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EDITORIAL

THE International Irrigation Congress is to be held at El Paso, Texas, October 14 to 18, in connection with the formal dedication of the Elephant Butte dam.

THROUGH an oversight, the chart for computing earthwork in ditches, appearing on page 359 of our September issue, was not credited to Mr. George Henry Ellis except in the table of contents. Readers will please note this correction.

AMERICANS who have felt humiliated at the spectacle of an abject surrender by the Government of those principles supposed to constitute the backbone of the American republic, may extract such comfort as they can from the fact that the threatened railroad strike has been averted.

DIVIDED responsibility in highway management appears to be as unsuccessful in Washington as it is in California. A short time ago the road commissioners for a certain county in Washington voted to discharge one of the road supervisors who had extensive outside interests. On investigation it was found that he kept his pay-rolls in a careless, unsystematic manner and had been in the habit of transferring men back and forth between his own work and that of the county. While no evidence of any dishonesty was disclosed, the commissioners wisely decided that a man whose private interests were so extensive did not have the necessary incentive to give his best attention to the interests of the county. It is equally impossible for supervisors in Californian counties to give proper attention to highway management in their districts. The sooner they decide to turn such matters over to a single trained official in each county and confine their own attention to other matters, the better it will be for all concerned.

The State Highways of California

Several years ago, the voters of California authorized a road-bond issue for $18,000,000. In this issue, we publish a report made for the California State Automobile Association by Mr. Eric Wold of San Francisco showing how this fund has been expended, the results accomplished, and commenting in general on the work done by the State Highway Commission and its engineers. We believe that all of our readers will be well repaid by reading Mr. Wold's report carefully. It is not so very long ago that the expenditure of money for public improvements was accompanied by inefficiency, waste, unskillful methods and worse. The work of the Highway Commission speaks for itself. California, in the vernacular, is on the map. It is known all over the United States as the motorist's paradise. No State in the Union has such roads, with the possible exception of New York, which has expended $100,000,000 while California was spending $18,000,000. Of the great resources of this State, our system of good roads comes first in the things that make life worth living. To some it may seem strange to list good roads as a resource. As a matter of fact, it is perhaps a greater contributor to the welfare and happiness of the people than anything else we have to offer, especially to those who dwell on the farms and in the rural districts, once, but now no longer, inaccessible.

The farmer was once the butt of the vaudeville humorist, the meal ticket of the mail-order house, a man afraid of a street car, one who gawked at high buildings. Now he drives his own car, patronizes the theatres and is able to participate in social activities with his neighbors within a radius of one hundred miles. The reason is good roads. The time lost in going and coming has been decimated, he handles his produce in one-quarter of the time and at one-quarter of the cost. It is not strange that when the first few miles of good roads were laid, the demand for more became so insistent that not merely the State, but counties, cities, towns and villages each had their good road projects, vieing with one another to produce a series of spotless towns, that would attract rather than repel the investors.

It has fallen to the lot of the California Highway Commission to produce good roads at low cost; this despite the many difficulties of engineering and construction existing in the mountain and desert regions. The adoption of the portland cement concrete base as a standard has been proved to be correct. Any roads that can stand conditions brought about by the floods in San Diego county and other parts of southern California last winter and still be roads have shown their worth.

The entire project, involving the construction of more than two thousand miles of trunk roads is not yet complete. The funds provided by the present bond issue were inadequate. In November the voters will have an opportunity to express their opinion on the issuance of $15,000,000 additional bonds with which to complete the system. With politics as politics we are not interested, but this is not a political issue, and most certainly not a party issue. It is an economic question of greatest importance, and is therefore worthy of the unanimous support of every resident of California who has the interests of his State at heart.

California is the land of opportunity. Opportunity needs capital for development. There is no greater attraction for capital than a State veined with good roads.

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We are strongly in favor of the proposed issuance of $15,000,000 additional bonds for State highway purposes, and hope that the great majority of California voters will, in November, express the same opinion.

The Quebec Bridge Disasters

By CHARLES EVAN FOWLER

The proverbial mantle of charity must be drawn and the Golden Rule must be observed in any discussion of the disasters that have befallen this seemingly ill-fated structure. Yet few will condone the greed that caused the fall of the first bridge, nor excuse any lack of judgment that may prove to be responsible for the loss of the great suspended span of the second bridge only a few days ago.

The great lesson to be learned by engineers and financiers is the necessity of more consultation on important engineering works, and a wider discussion of the designs of such great structures. They, in common with the pyramids, though not so lasting, belong to all times and all peoples; are the common heritage of all engineers, and their success or failure makes for the weal or woe of the profession as a whole. When successful, there is glory enough for all.

It would seem that a great constructor, not an engineer but one quick to see the vital points in a scheme of erection, might, from mere appearances have questioned the sufficiency of the shoe supporting the span on the hanger girders. Hindsight is proverbially, even notoriously, better than foresight, but is it not strange that some one did not question this pigmy detail for the transition period in the building of this giant of bridges?

The theoretical man exercised his skill in designing chord-sections for the first bridge of the least weight in details; the practical shop-man raised a question as to their sufficiency, but he was ignored; a great bridge was wrecked, many lives lost, and the odium was the common lot of engineers of all lands.

The question was then asked, do engineers know enough, have they data enough from which to design the great members of a giant bridge, and the answer finally was in the affirmative, but this knowledge was not used, nor the 'safety first' requirement remembered. When the trouble developed in the buckling of one of the bottom chords near the main pier, due to insufficient detailing, the warning was not heeded until too late, and an error of judgment contributed to the ultimate failure.

The second bridge designed, was a 'last word' to overcome the faults of the first design; but the real reason why the towers were not planned with a height, either permanent or temporary, that would permit the erection of the suspended span by the cantilever method, is again not to the credit of engineers, in that such a saving of money has not proved to be true economy.

Granting, however, that the erection of the suspended span by floating it in and hoisting to place, was a true economy, then as the sequel proves, everything should have been designed both as to permanent and temporary details, with preparedness for every emergency and for all contingencies. While probably it will never be known to the fullest extent desirable, exactly what happened nor what broke, it seems certain that the 'universal' shoe carrying the span on the hanger girders, was designed of insufficient size, was too light in detail, and was not properly fastened either as a whole or in detail. How small the first cost to have made it right, as compared with the apparently uncounted cost of a failure! Poor Richard said, "A little neglect may breed mischief." "For want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the rider was lost; for want of the rider a kingdom was lost."

The original plan for a Quebec bridge with a clear span of 1442 feet was prepared by the English engineers, Sir James Brunlees and Mr. A. Light, assisted by Mr. T. Claxton Fiddler, the engineer-author, and this, as well as the design of the second bridge of 1800-foot span, which failed, was a valuable study looking toward the ultimate successful bridging of the St. Lawrence river at this point. The second design was, however, an unnecessarily costly study, and with proper consultation and a wide discussion the failure of the first bridge to reach beyond the construction stage should never have occurred.

The lesson may be applied close at home to the case of the proposed bridge over San Francisco bay, and the great value of the designs proposed become apparent, even though it may be many years before any bridge is finally constructed. Shall the lesson learned at the Firth of Tay as to a high and top-heavy structure be taken seriously? Shall the questions answered by the construction of the great Forth bridge, and in the two attempts at Quebec, be the guide to a proper solution of bridging the bay at San Francisco and bring about the adoption of a great structure to be built without costly mistakes of design or construction?

This result may be obtained only by the widest publicity of designs; by the fullest possible discussion; by the best of consultation after the fullest investigation of all problems, however remote may be their connection with the project.

> "Then prove we now with best endeavor,
> What from our efforts yet may spring.
> He justly is despised, who never
> Did thought to aid his labors bring.
> For this is art's true indication,
> When skill is minister to thought,
> When types that are the mind's creation,
> The hand to perfect form hath wrought."

To our fellows and friends, the distinguished engineers of the Quebec bridge, with apologies for our seeming criticisms, we extend our sincerest sympathy and the promise of our earnest moral support. That the bridge was properly designed, that the wreck was due to no fault of theory, nor its application, so far as the permanent structure is concerned, we know. We are equally sure that these same engineers will carry the structure to successful completion to the credit of the engineering profession, and to the ultimate satisfaction of all. To them success and Godspeed!

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REVIEW OF THE MONTH

FIFTY-TWO gravity oil is now being shipped by the State Consolidated Oil Company from its well a few miles from Ventura. This is the lightest oil ever produced in the State, the present output being 100 barrels per day from a depth of 2250 feet. According to the new schedule of prices just announced by the Standard Oil Company, this oil is worth $1.50 per barrel at the well. This is the first successful well that has been drilled in this district. The Shell Company has acquired options recently on a large acreage in this vicinity and has already carried its first well to a depth of 1000 feet.

SHIPMENTS of oil from Californian fields during August exceeded all previous records. The daily average was 308,000 barrels. In June 1914, just before the War, the daily average was 300,000 barrels, the nearest approach to the high mark for August. Production during August was but 260,000 barrels, indicating that 1,500,000 barrels was withdrawn from storage. This is not an encouraging symptom to those who are looking forward to a reduction in the price of gasoline and other refined products. The increased cost of drilling is a natural corollary to the present high price of all steel products. This in itself has a tendency to retard development, so no large increase in production seems probable. The recent action of the Standard Oil Company in increasing prices of crude oil was to have been expected and is in line with the general conditions. Fuel oil in the San Joaquin Valley fields is now bringing 68 cents per barrel at the well, the highest price since the discovery of the Kern River field in 1899. Proportionate increases have been made in the prices for other grades. 'Dollar oil by 1917' is hardly likely, but it might easily come within the next 12 or 18 months.

CONTRACTORS who bid on municipal work in California should fortify themselves with the best legal advice obtainable 'and then some,' if they do not wish to find that through some legal quibble or quirk the money due them cannot be collected. About a year ago the city of Stockton called for bids for re-paving several streets. The ordinance provided that payments would be made in three annual installments. After the work was started, a tax-payer secured an injunction, which later was made permanent, on the ground that the three-year-payment clause was illegal because the city council had no power to incur a debt for more than one year without calling upon the people to vote bonds. When the contractors sued the city for the $18,000 or so that they had already expended upon the work, the judge ruled that they could recover nothing. We presume that at the time the suit was brought it was the open season for contractors and that anyone, including judges, might shoot them at sight. This decision may have been rendered in accordance with the rules of the law game, which unfortunately seem to have little bearing upon justice.

AMERICAN engineers who have advocated preparedness now have a genuine opportunity to apply their patriotism to some practical purpose. The War Department has announced the qualifications required for commissions in the reserve corps of engineers for the United States army. Commissions will be issued for the grades of major, captain, and first and second lieutenants. Those to whom commissions are awarded are subject to duty in instruction camps for two weeks in each calendar year. A reasonable latitude in the choice of time for this service is to be allowed. All officers are subject to call for duty when war is actual or imminent. All candidates must pass a rigid physical examination, while mental examinations will be conducted orally under the auspices of regular-army engineers. The professional qualifications for major, captain, and first and second lieutenants correspond roughly to those for member, associate member, and junior in the various National engineering societies. Examinations on the purely military phases of the officers' duty, such as drill regulations and duties of officers, will vary according to rank. Commissions will be issued for a term of five years but are renewable after a physical examination, subject to approval by the Secretary of War. Candidates may obtain application blanks from the Chief of Engineers, U. S. Army, Washington, D. C.

SAN FRANCISCANS and others are still discussing trans-bay bridges. The engineering corps of the United States army is having a busy time with hearings of one sort or another. On September 12, Lieutenant Colonel Thomas H. Rees conducted a hearing on the subject of bridges across the Oakland estuary. The present swing bridges are of an obsolete type and are a hindrance to navigation and land travel. On account of the great length of approaches, the cost of a subway would be more than ten times that of a bascule bridge of the same capacity. While the War Department has not yet rendered its decision, it seems likely that it will authorize the removal of the present bridges and substitute therefor either one or two quick-opening bridges of the bascule type. In the meantime, the trans-bay bridge epidemic has broken out among the residents of Marin county, who have decided that they also are not enamored of ferry-boats. A bridge or tunnel project across the Golden Gate is being advocated, as usual with-

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out any engineering investigation. While the distance to be spanned is considerably less than in the case of any of the projects to connect San Francisco and Alameda county, the population and resources of the tributary territory are much smaller. We would like to see some serious effort made toward a real investigation of the bridge and tunnel projects. By 'real investigation' we mean one fortified by dollars instead of words.

WE have frequently commented on the fact that engineering is the poorest paid of all the professions. An interesting comparison may be made of the relative remuneration of lawyers and engineers through the action taken recently in a small San Joaquin Valley community. It seems that the farmers are preparing to oppose an attempt by the local canal company to increase rates for irrigating water. To meet the expense, a total of $3500 has been provided, $2500 of which is to go to the lawyers handling the case, while $1000 has been lavishly provided to cover engineering and incidentals. Why not engineering and other incidentals, since unfortunately, engineering seems to be regarded as more or less of an incidental in all of the big work that is done? One of these days we hope that the engineering profession as a whole may shake off its lethargy and shed some of that peculiar conception of the ethics of the profession involving the preservation of a mummy-like silence while the layman fills all of the best positions, gets the cream of the payroll, and hires the engineer to do his thinking for him at a small remuneration.

THE expenditure of State highway funds in California is limited to unincorporated territory. In the case of the large cities this has made little difference, since the highway has usually followed paved streets. In a few cases where some of the streets have not been paved, it has been a simple matter to remedy this defect; in smaller cities and towns, however, it is difficult to raise the necessary funds to pave the gap between the terminals of State highways. Civic pride, plus the fear of losing the money that might be spent by visiting motorists, either voluntarily or in paying fines for speeding, has been a powerful stimulant toward providing funds. A movement has been started in some of the smaller municipalities threatening opposition to the proposed $15,000,000 bond issue unless the Commission will agree to spend part of the State funds within incorporated town limits. It might be stated in passing that the futility of adopting such tactics is obvious to anyone familiar with the personnel of the present State Highway Commission. Nevertheless, the citizens of Yreka were invited to join this movement, but to their credit they refused absolutely. Their letter of reply states in substance that the State highway through Yreka has already been paved at the city's expense, that the Commission is justified in refusing to spend State funds on roads over which it would have no control, and that any departure from this practice would result in sacrificing the interests of many for the benefit of a few. If this is the character of such opposition as has been expressed to the proposed State bond issue, there should be hardly more than a baker's dozen of votes cast against the measure.

SHORTAGE of freight cars in the United States is becoming more serious daily, with every indication that the situation is likely to grow worse instead of better. The effect of drastic legislation providing for all sorts and conditions of freight-rate regulations has had a tendency so to depreciate the value of railroad securities that it has been practically impossible for the railroad companies to raise funds for betterments. The enormous increase in the volume of freight handled by the railroad companies during what might be termed the munition-order period, has greatly overtaxed freight-handling facilities, not only as to cars but terminal equipment as well. Some cement manufacturers suggest that wherever possible, orders be placed for "one car, any size," or "two cars, any size," rather than for a definite number of sacks. Thus manufacturers could load so as to get the maximum carrying capacity of each car. The same course is possible for other articles besides cement. Those who may reasonably expect to be in the market for any commodities during the coming winter months will do well to place their orders now and store, rather than run the risk of interruption or possibly a complete stoppage of their business on account of inability to obtain material.

ANNOUNCEMENT of the tentative distribution of the amounts available for highway construction in the National Forests has been made by the Secretary of Agriculture. Of the $1,000,000 appropriated each year for the next ten years, 10% is to be withheld for a contingent fund to provide for expenses of administration. Any balance remaining after these have been paid is to be used at the discretion of the Secretary of Agriculture to increase the appropriation for any particular State where there may be an immediate need for an expenditure greater than the regular allotment. The remaining 90% will be apportioned among the several States as follows: One-half according to the ratio between the net National Forest area in each State to the total land area of that State, and one-half according to the ratio between the estimated value of the timber and forage resources of the National Forests in each State to the total value of the timber and forage resources of the National Forests. On this basis the amounts for the several States each year are as follows: Arizona, $59,795; Arkansas, $11,294; California, $140,763; Colorado, $62,335; Idaho, $108,010; Montana, $69,901; Nevada, $19,195; New Mexico, $42,622; Oregon, $127,794; South Dakota, $8115; Utah, $40,982; Washington, $91,739; Wyoming, $40,556. In addition, $9552 has been assigned tentatively to Florida, Michigan, Minnesota, Nebraska, North Dakota, and Oklahoma, and $21,057 to the various Eastern States where the Federal Government is now purchasing land for forest purposes.

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DISCUSSION

The Proposed Feather River Highway

The Editor:

Sir—I submit a few reasons why the North Fork of Feather river should be adopted as a route for a highway across the Sierras in preference to any other route.

The altitude of the summit of the Sierra Nevada mountains, which is the divide between the Great Basin and the Pacific ocean, at Beckwith Pass, is 5220 ft. and from this point the descent is gradual and continuous to the Sacramento valley at Oroville. The Western Pacific Railway Co. adopted this route and reached Oroville without an adverse grade, and with a maximum grade of 1%. Such a line could not be expected for a highway, but no heavy grades would be necessary.

The snow fall on this route is less than on any other across the Sierras. It is a mistaken idea that the depth of snow fall is governed entirely by altitude, for at Beckwith Pass the greatest depth of snow is not more than 27 in.; at Portola, altitude 4850 ft., the snow is 4 ft. deep in severe winters; at Spring Garden, on this route, altitude 3960, the snow sometimes reaches a depth of 5 ft. At Indian Falls, altitude 3250, the snow is about 2 ft. deep in a severe winter. From Indian Falls down the snow decreases in depth, till Belden is reached, from which point there is practically no snow. The past winter was one of deep snows in the Sierras, but on February 15 there was none whatever between Indian Falls and Oroville. Had there been a road from Quincy to Oroville following this route, there was no time during the past winter that a team could not have gone over the road, and it would have been open for automobiles by February 1.

My idea of a road from Oroville, *via* the North Fork canyon is by way of Yankee Hill to Big Bar. Between Oroville and Big Bar, a good road is already built with the exception of about 2½ miles. At Big Bar, I would adopt the road constructed by the Utah Construction Co. as far as Rich Bar. From this point, I would cross the river and construct a new road on the south slope of the mountain to Indian Falls, a distance of about 18 miles. At Indian Falls this road would intersect the main thoroughfare of Plumas county, 13 miles north of Quincy and 5 miles south of Indian valley. From Quincy east a good grade is already built to Reno, and from Indian Falls there is a good auto road *via* Lake Almnor and Westwood to Susanville.

In ordinary seasons, this route from Oroville *via* Indian Falls and Quincy to Reno in Nevada, would be open at least eleven months in the year, and sometimes all winter. About once in ten years, we have a heavy snow fall which closes the road from Quincy to Reno for from one to two months. In my opinion this route would make the best military road possible across the Sierra Nevada mountains to the Sacramento valley. From Oroville to Big Bar, by way of the North Fork of Feather river and alongside of the Western Pacific Railway, the Utah Construction Co. built a road over which they conveyed their supplies when building the railroad. The objection to this route is its close proximity to the railroad, but this may not be objectionable in the opinion of engineers making a close examination.

The material along the line of road suggested is good for road building. Gravel is easily accessible, and rock suitable for road purposes is easily obtained along the line.

This road, if built, offers many advantages over all other roads either constructed or contemplated across the Sierras. The advantages may be summed up as follows:

1. The distance and easy grades.
2. The light average snow fall.
3. The period of each year open to travel.
4. The comparative cost of construction.
5. The advantages open to tourists.
6. The scenery, which is the grandest in Northern California and which would delight the eye of the tourist throughout its entire length.

A. W. KEDDIE.

Quincy, California, September 9.

Computation of Canal Excavation

The Editor:

Sir—In preparing the text for the diagram published in your September issue, you have missed the particular thing for which this diagram was designed. The two sides of this diagram were so placed as to allow for 10% shrinkage. For example, you will notice that 100 cu. yd. of excavation is placed opposite 90 cu. yd. of fill. In your first problem for example, where you read 110 cu. yd. of embankment, you should also read on the right 122 cu. yd. of borrow, or rather 72 of borrow plus the 50 of canal prism, to make that bank.

It is sometimes possible to locate a canal so that there is just enough material in the canal prism to form the banks; that is there is neither borrow nor waste. Such a canal is said to be in economic cut, and is the ideal which we always try to approximate as nearly as possible. Therefore after designing a canal section, and before going into the field to locate it, we always figure how deep in the ground to put it in order to obtain the above condition; in other words, what is the economic cut for this section? If, in your first problem, you had chosen a cut of 1.6, and a fill of 1.4, you would have noticed that they were horizontally opposite to each

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other, and that therefore a cut of 1.6 would give just enough dirt to make the banks, allowing 10% for shrinkage. That is, the economic cut for that section is 1.6. Now for your other section run up the 8-ft. bottom width and the 3-ft. top width until you find a cut and fill horizontally opposite which, added together, equal the height of bank. This will give you the economic cut for this section, about 1.33. This is the particular thing for which this diagram was designed, though of course we use it also for making estimates of yardage.

GEORGE HENRY ELLIS.

Fort Shaw, Montana, September 11.

BELT-CONVEYORS

For moving material supplied in a continuous stream, a belt-conveyor is well adapted. The capacity of a narrow belt is surprisingly high in consequence of the speed at which it may be run. Reginald Trautschold, writing in the *Engineering Magazine,* gives the most economic speed for various materials handled by belt-conveyors. Coke is best conveyed at 250 ft. per minute. Coarse broken stone and lump coal should also have low speeds, about 275 ft. per minute. Fine coal, however, is best handled at the high speed of 400 ft. per minute. Sand or gravel and ordinary crushed stone, are conveyed most economically at 375 ft. per minute. A belt-conveyor 1 ft. wide can handle nearly 90 tons of sand per hour, while one 3 ft. wide has a capacity of 800 tons per hour, or nine times as great, in each case run at a speed of 375 ft. per minute. These figures apply only when conditions are working perfectly. The power requirement of belt-conveyors is low. A 30-in. belt, when working at most economic speed, can handle 270 tons of fine coal per hour, elevating 20 ft., and distributing the coal by an automatic tripper over a 50-ft. storage-bunker, at a requirement of 13½ hp., of which 5½ hp. would be needed for the horizontal travel, 5½ for elevating the load, and 2½ for the tripper, the conveyor being equipped with grease-lubricated idlers. If ball-bearing idlers are used, the power consumed would be 11¾ hp., the reduction of 1¾ hp. being principally the saving in friction on the horizontal travel.

The best grade of rubber is none too good for a conveyor, as its large capacity makes initial cost secondary in importance to that of wearing quality. The labor charge for inspecting and repairing conveyors is generally taken at 1½c. per hour per inch of width. The cost for grease and incidental supplies varies directly with the horse-power consumed, and averages ⅝c. per hp. per hour. Depreciation of a belt comes from hardening of the rubber, and is more apt to follow idleness than careful use. Ordinarily, an annual depreciation charge of 25% on the belt covers the wear and tear. The net operating cost on an 18-in. belt-conveyor, 500 ft. long, handling 85,000 tons of fine coal at a rate of 85 tons per hour for 1000 hours per year, was less than 2c. per ton. This conveyor elevated the coal 30 ft. and distributed it over a bunker 100 ft. long by means of an automatic traveling tripper, power being furnished at 2c. per hp.-hour. The speed was 400 ft. per minute; the power was 14 hp. (11 hp. if roller-bearings are used); the initial cost of equipment was $3720; depreciation was charged at $710 per year; annual fixed charges were $316; labor cost $270 per year; and power cost $280 per year.

When a large quantity of material has to be handled at a rapid rate in a limited space, and the cost for power is not so important as the initial investment, flight-conveyors may be used. While their speed is slow, the load per foot is high. The best advisable speed is 100 to 200 ft. per minute. A horizontal flight-conveyor, 8 by 18 by 16 in., 150 ft. long, handling 150,000 tons of fine coal in 600 operating hours, the power costing 2c. per hp.-hour, would have a net operating cost of 0.8c. per ton. The advisable speed would be 200 ft. per minute; the capacity 260 tons per hour; the power required would be 31½ hp. costing $378 per year using shoe-flights, or 28½ hp. costing $342 per year using roller-flights; the initial cost of equipment would be $655 with shoe-flights or $880 with roller-flights.

Screw-conveyors have comparatively a limited capacity and a high consumption of power. They are particularly well liked for handling cement. Though cheap in first cost, the depreciation is rapid; the screw revolving in the load receives destructive abrasive action. The economic speed is governed by the diameter of the screw.

INDUSTRIAL INJURIES IN CALIFORNIA DURING 1915

The Industrial Accident Commission of the State of California has issued statistical information concerning injuries in the industries of the State during the year 1915.

There were reported 67,538 injuries, as follows:

Fatal	533
Permanent	1,264
Temporary	65,741

The total payments for the above injuries, reported up to June 30, 1916, amounted to $2,002,706.04. This sum was apportioned between

Compensation to injured	$1,150,503.56
Medical payments	852,202.48

There were 13,254 injuries out of the 67,538 where disability lasted 15 days or more.

It is interesting to compare the 1915 figures with those tabulated for 1914. During the latter year there were 691 fatal accidents, 1292 permanent injuries and 60,241 temporary injuries, a total of 62,224. Last year's death list shows a reduction of 158, due largely to the gospel of 'Safety First' and the activities of employers and employees in co-operating to remove industrial hazards. The permanent injuries also decreased 28. There was an increase of 3500 in the temporary injuries last year as compared to the 1914 figures. This is largely because of more care being taken in reporting injuries. The natural increase in population also results in increasing the number of temporary injuries to be reported.

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The State Highways of California*

By ERIC WOLD †

The State Highway Act of 1909, approved March 22, 1909, provides that "A system of highways in and for the State of California shall be constructed and acquired in the manner provided by law, by the department of engineering of said State, at a cost not to exceed $18,000,000." Further, Section 8 provided that "The highways constructed or acquired under the provisions of this act shall be permanent in character and be finished with oil or macadam or a combination of both, or of such other materials as in the judgment of said department of engineering shall be most suitable and best adapted to the particular locality traversed." The act was approved by a vote of the people of the State of California in November 1910, and became effective on the 31st day of December 1910.

The theory that "Highways permanent in character * * * finished with oil or macadam" can be constructed to withstand modern automobile and automobile-truck traffic is now recognized by road engineers as unsound. By proposing this impractical construction the highway proposition was therefore launched on an unstable footing. However, a highway commission was created and the resulting roads have justified its existence. The $18,000,000 is practically expended and instead of receiving and having a quantity of temporary macadam or oil-macadam roads, we have 966 miles of permanent concrete and asphalt pavement and only 129 miles of temporary oil-macadam. We also have 395 miles of well-graded dirt road which can be made into permanent highway when the money is forthcoming.

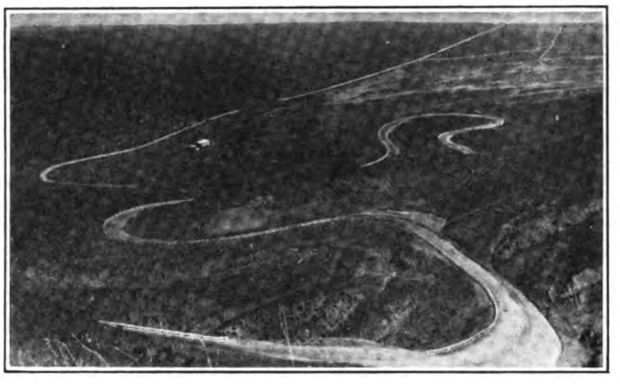
To accomplish this great work, the Commission built up a wonderfully efficient organization. This was not done in a day or a year, but by the sifting, trying out, and education of the members and units at a great expense. At the present time this organization probably handles its business at a cost of one-half of what it did in the first years of its existence. The Commission established six departments, namely: engineering, legal, purchasing, laboratory, and accounting, with the state highway engineer as the chief executive.

Engineering Department. The State is divided into seven divisions, each in charge of a division engineer.

It has been the aim of the Commission to establish and maintain a high standard of professional efficiency among its employees. I have met several of these engineers and have been impressed with their spirit. I feel that their hearts are in their work and that only the best will be received from every dollar expended.

It is upon the engineering department that the burden of responsibility falls, not only as to the success and permanency of the work done, but also the economy of construction and overhead expense.

Engineering Work. In the selection of routes the Commission was governed by the following provisions of the act: "The route or routes of said State highway shall be so selected and said highways so laid out and constructed (or acquired) as to constitute a continuous and connected highway system running north and south through the State traversing the Sacramento and San Joaquin valleys and along the Pacific Coast by the most direct and practicable routes, connecting the county seats of the several counties through which it passes and joining the centres of population, together with such branch roads as may be necessary to connect therewith the several county seats lying east and west of such highways." This general scheme has been literally followed.



PART OF LOS ANGELES-BAKERSFIELD HIGHWAY. OLD GRADE IN FOREGROUND.

In the establishment of these routes it was necessary to make reconnaissance surveys to determine the practicability of making use of the existing roads between centres of population, and to determine what changes of alignment or grades would be necessary to bring the road up to certain fixed standards for State highways. Valley roads excepted, it was found necessary to abandon the existing roads and make new locations. The valley roads comprise less than 30% of the total length of road located and constructed.

The general routes having been established, the location surveys were made, the property lines and right-of-way determined, also areas of water-sheds and the maximum rainfall and run-off. The sizes of bridges and culverts were calculated, grades determined, the lines staked and cross-sectioned, the quantities of excavation and fill calculated. Topographic and geological surveys were made of the adjacent territory with

*From report prepared for California State Automobile Association.

†Consulting engineer, New Call Bdg., San Francisco.

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the object of finding rock, sand, and gravel that might be used economically in the construction of the road. Because of this, when the headquarters staff worked up the detail plans, specifications, cross-sections, etc., showing every detail of construction and submitted the work for bids, the contractors were given the fullest information obtainable, which resulted in the keenest of competitive bidding.

Engineering Feats. Among the many feats of engineering accomplished by the department of engineering of the State Highway Commission which will result in the saving of large sums of money and in facilitating transportation in various districts, the following may be mentioned:

1. The construction of an air-line road from Los Angeles to Bakersfield, thereby saving 25 to 46 miles of distance, according to route chosen, and obtaining easy grades, the maximum being 3 miles of 6%, as against 20% formerly.

2. The construction of the San Jose to Salinas road by way of Gilroy and San Juan, thereby eliminating the old San Juan grade, and substituting a highway having mostly 2 to 4% grades with only a small amount of 6% maximum grades.

3. The elimination of the Bell Spring grade on the Mendocino-Humboldt line. By a change of route, 2686 ft. of rise and fall, having as high as 30% grades, will be eliminated and grades reduced to a maximum of 6%.

4. The construction of the Yolo Basin viaduct, thus connecting the two sides of the Sacramento valley and affording the only all-year highway crossing of the waters of the Sacramento river between the bridge near Chico and Benicia ferry, a distance of 200 miles.

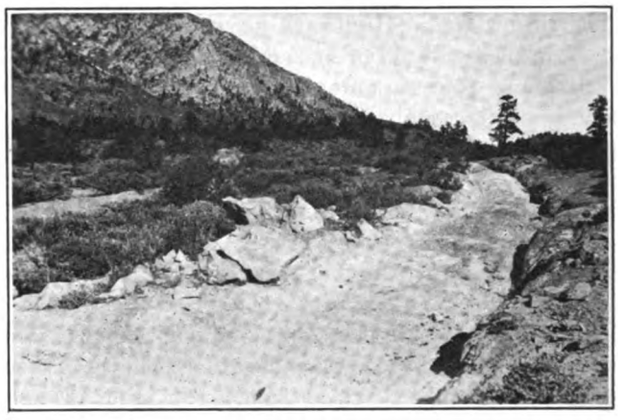
Numerous other reductions in distance and grade have been made with resulting economy, among which may be mentioned the elimination of 143 railroad grade-crossings. Two thousand three hundred and fifty miles of final location survey has been made, which represents many times that mileage of reconnaissance and preliminary surveys.

Rights of Way. The work of the engineering department, with the help of the legal department, in securing the necessary rights-of-way has been difficult and expensive. The policy of the Commission required that these rights-of-way, of from 50 to 60 ft. in width, be delivered to the State by the several counties free of cost. However, it was incumbent upon the highway engineers to prepare the plans, maps, and descriptions of these parcels of land. Further, the Commission's right-of-way agents have handled most of the negotiations with the property owners. The cost of this work to the Commission, which would have been required in any event, will probably equal the purchase price of the lands secured, which cost has been saved in the manner above stated.

Materials. Although the cost of maintaining the purchasing department is low, the field cost of handling the large quantities of materials used has been enormous, and this cost has naturally been charged to the engineering department. The engineering department has, therefore, been forced to act as 'materials man' for the contractor. We know that the contractor's overhead, which amounts to between 10 and 20%, consists chiefly of the cost of caring for the purchase and delivery of materials. The State Highway Commission made a gross saving of about $500,000 on these purchases, including freight reductions. The cost of handling these materials is really construction cost and should not be charged to engineering overhead.

Legal Department. The work done by this department is important, though the cost is nominal, a little in excess of $30,000. The legal department has, by cooperation with the engineering department and right-of-way agents, secured all rights-of-way required. The fact that no injunction or ejectment proceedings have been instituted speaks well for the efficiency of this department.

Testing Laboratory Department. The policy of the Commission in establishing a testing laboratory was undoubtedly a wise one. While it would have been possible to have had materials tested by the State laboratories or by testing corporations, it is doubtful if such a system would have been at all desirable. In the first place the cost would have been greater than the present system, and again, many tests, studies, and experiments were carried on which would have been impossible except in a laboratory owned and operated by the Commission. Further, an organization has been created, even though it may be small, which is intensely interested in the study of road-building materials and which has been loyal in its endeavor to see that nothing but the best available materials are incorporated in the work.



EXAMPLE OF OLD ROAD, NOW REPLACED BY PAVED HIGHWAY.

Besides making general geological studies along the different routes of the State highway and particular field investigations at various points, the testing department has made the following tests during the four years of its existence:

Material tested	Number of tests
Sand	562
Gravel	168
Cement	1,624

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Material tested	Number of tests
Concrete	656
Rock	178
Road oil	865
Asphaltic cement	280
Asphaltic surface	681

We have estimated that to have had these tests made by a testing corporation would have cost the Commission about $40,000. The entire expense of this department, including salaries, was $27,690.33, showing therefore a direct saving of $12,309.67. It should also be borne in mind that at all times the Commission had the service of an expert geologist, the head of the laboratory department, at its command.

Accounting Department. The accounting department has handled a total of $16,821,703.98. In general, all expenditures have been charged under the heads shown in the following statement:

STATEMENT OF EXPENDITURES, CALIFORNIA STATE HIGHWAY COMMISSION, TO JUNE 15, 1916

1. Construction cost (expenditures for payments to contractors and material men and for labor and material on day-labor contracts)	$14,284,552.11
2. Equipment (1.15% of construction cost, expenditures for all classes of equipment and furniture)	164,394.46
3. Expenses (16.64% of construction cost, expenditures for engineering, legal, accounting, purchasing, laboratory, services and incidental expenses of each department)	2,372,757.41
Total expenditure to June 15, 1916	$16,821,703.98
Total amount available from State Highway fund	18,000,000.00
Unexpended balance June 15, 1916*	$ 1,178,296.02

*Since June 15, 1916, the Commission has obligated itself for the expenditure of the balance of $1,178,296.02, by the execution of certain contracts for work and materials.

With reference to the method of accounting it may be said that an account of each contract has been kept showing the amount paid to the contractor each month, the amount chargeable for preliminary engineering, engineering, supervision, and inspection during construction, and materials delivered to the contractor, including freight on same. Overhead expenses, such as accounting and division-office expense, have also been charged to the various contracts, but no head-office expense has been so charged. When construction work has not been commenced or completed on various sections, the expenses incurred in the different departments in preliminary work are not distributed until the completion of contracts and are carried as undistributed expenses.

Account No. 1, 'Construction Cost,' consists of—

(*a*) Payment to contractors.

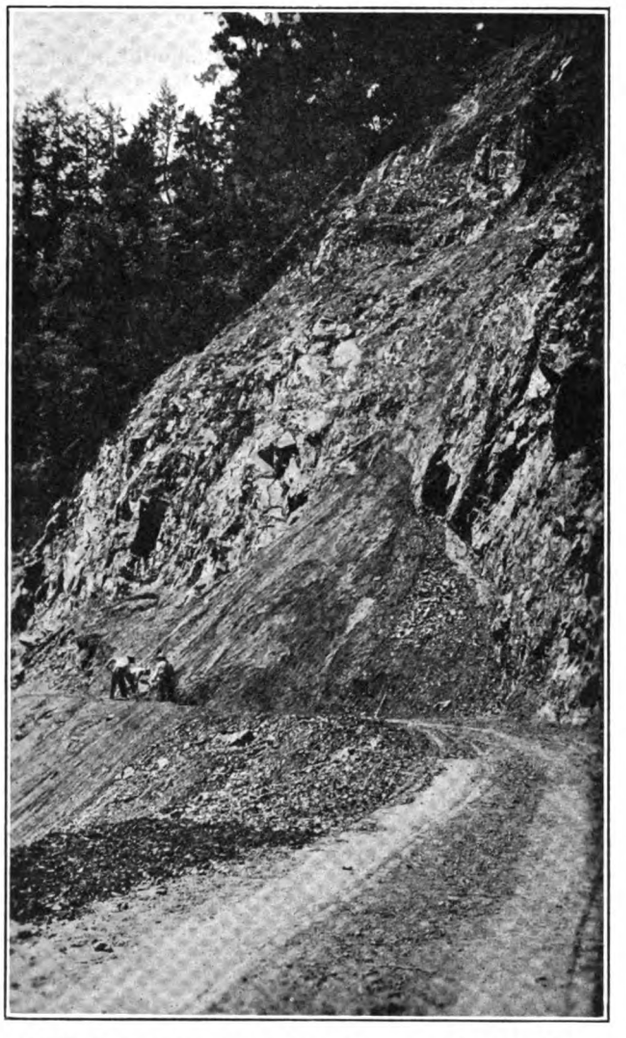
(*b*) Payments for material and freight.

(*c*) Payments for labor and material on day-labor contracts.

We have examined in detail 175 contracts and find that the unit prices are all reasonable and well within the limits to be expected for the class of work required and under the various local conditions prevailing. The following are the average prices paid for the principal units of the work, including cost of materials:

Item	Unit cost
Excavation, including clearing right-of-way, shaping and finishing of roadbed, watering and rolling, all classes, per. cu. yd.	$0.41
4-in. concrete pavement, per sq. yd., including materials.	0.738
1½-in. asphalt wearing surface, per sq. yd., including materials	0.45
⅜-in. oil top, per sq. yd., including materials	0.054

We have examined the records of the purchasing department and, as previously stated, have found that a



CONVICTS WORKING ON HIGHWAY IN MENDOCINO COUNTY.

saving of about $500,000 was made in the purchase of material.

We have examined the record of day-labor contracts on 67 miles of work and find the unit costs for the work to be as low as for the same class of work let under open bidding.

Therefore, we are of the opinion that expenditures under this account have been reasonable and justifiable.

Account No. 2, 'Equipment,' consists of expenditures for equipment which we consider to be reasonable in size, considering the volume of the work done.

Account No. 3, 'Expenses,' consists of expenditures

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arising from work performed in the different departments. The work done consists of the following: Preliminary and location surveys, construction engineering, inspection and supervision, material distribution and purchasing, legal and rights-of-way, laboratory and accounting, with all incidental expenses. As many of the contracts are not completed, the overhead has not yet been distributed to the several accounts above mentioned and must, therefore, be carried as a whole.

Overhead. By reference to the statement of expenditure it will be seen that the gross overhead is 17.79% of the construction cost. This includes equipment of 1.15% and expenses of 16.64%.

This is not the true overhead and should be reduced for the following reasons:

1. Of the total of 2350 miles of road surveyed at a cost of $744,957.09, or $317 per mile, but 1490 miles has been improved, as follows:

	Miles
Oiled macadam	129
Concrete pavement	933
Asphalt	33
Graded only	395
Total	1,490

There are, therefore, 860 miles of highway located and ready for construction which cost $317 per mile to locate or a total of $272,620.

This mileage of surveys was necessary because the several counties met with much difficulty and delay in securing necessary rights-of-way. The Commission was therefore forced to construct disconnected lengths of road, although the entire highway had to be surveyed and located to determine the feasibility of the route and location of those parts that were constructed.

2. The engineering department gave certain assistance to the counties in the design and construction of bridges and in the checking and approving of numerous bridge designs submitted by the counties. After a careful investigation we believe that over $15,000 was expended in this manner, without reimbursement from the counties.

3. The engineering department was of necessity responsible for the handling and delivery of all materials used on construction and in so much as this work usually devolves upon the contractor, who figures his overhead charge of from 10 to 20% of the net of the contract, it is only reasonable that money so expended should be charged into the work and not as an overhead. We have estimated that $288,000 should be subtracted from the gross overhead for doing this work.

4. Account No. 2 in the statement of expenditures represents the purchase of equipment which we estimate as follows:

Equipment	Cost	Proportion of salvage %	Present value
Sand plants	$27,259.19	100	$27,259.19
Construction equipment	21,257.49	100	21,257.49
Engineering equipment	25,716.10	50	12,858.05
Furniture	21,328.05	40	8,531.22
Stable	$17,070.99	100	$17,070.99
Automobiles	41,380.55	40	16,552.22
Camp	6,429.32	20	1,285.87
Laboratory	3,952.74	50	1,976.35
Total	$164,394.46		$106,791.38

Whereas, we find in these items of equipment, sand plants, construction equipment and stable equipment, all of which are used in construction, it therefore becomes apparent that construction costs are entered into overhead accounts. To determine to what extent this is true is impossible at the present time, but the amount will undoubtedly reduce the overhead expenses appreciably. As shown above, we estimate this sum to be $106,791.38, which should be subtracted from the gross overhead.

We, therefore, would rearrange the statement of expenditures as follows:

REVISED STATEMENT OF EXPENDITURES:

Construction cost (unrevised)	$14,284,552.11		
Add for cost of handling material	288,000.00		
			$14,572,552.11
Gross overhead (unrevised)		$2,537,151.87	
Less 860 miles surveyed	$272,620.00		
Less bridge designs	15,000.00		
Less handling material	288,000.00		
Less equipment used on construction	106,791.38	682,411.38	1,854,740.49
Net total expenditure			$16,427,292.60

The net overhead then is seen to be $1,854,740.49 or 12.75% of the gross construction cost of $14,572,552.11. As before stated, considerable construction costs undoubtedly are still contained in the overhead expenses.

In conclusion, we would say that taking into consideration the thoroughness with which the Commission has prosecuted its work, we are of the opinion that the charge of 12.75% for overhead is a reasonable one; that the prices obtained are low and that a high standard of construction has been maintained. In railroad work with a permanent organization, trained through a long period of years, and with a standardized practice the average overhead charge is about 10%, so that the extra 2.75% is natural and lower than to be expected on public work. If the voters of the State entrust this organization with the expenditure of $15,000,000 proposed by the Highway Act of 1916, to be voted on in November, the Commission may be expected to be able, because of this organization, to make a better showing than has been made in the expenditure of the funds from the first bond issue.

In blasting, the more nearly the charge of explosive is adjusted exactly to the burden of rock, the more complete should be the explosion and the less should be the fume. The pressure of the explosion is greatest when a charge is carefully adjusted to the burden, the thermodynamic changes being interdependent. Over-charging of holes in blasting is customary.

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Electric Power Required for Various Oilfield Operations

A paper on 'Motor Equipments for the Recovery of Petroleum' by W. G. Taylor, presented at the annual convention of the American Institute of Electrical Engineers, contains data regarding the amount of power consumed in various oilfield operations. Handling the casing is recognized as the operation that makes the heaviest demand on the prime mover, whether steam-engine or electric motor. Fig. 1 shows graphically the variations in the power required. The motor in question was rated at 50 hp. The character of bailing and drilling requirements is shown in Fig. 2. It should be remembered that both these diagrams read from right to left. The total consumption of power during the drilling of any given well will vary approximately as the square of the depth of the well. From actual records, an 800-ft. well required about 3000 kilowatt-hours, while a well 2060 ft. deep required about 37,000 kilowatt-hours. Slip-ring induction motors are generally used for drilling. A 50-hp. is usually employed for wells up to 2500 ft. deep, but a 75-hp. motor is sometimes needed.

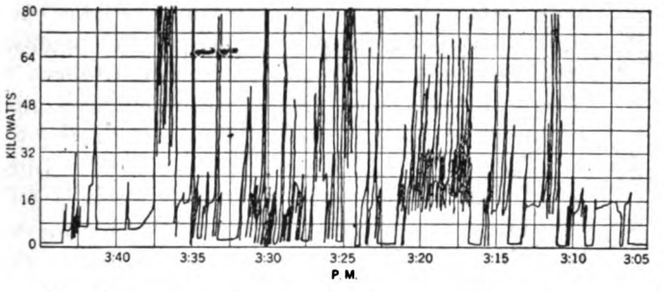

FIG. 1. CURVE OF POWER DEMAND IN HANDLING CASING.

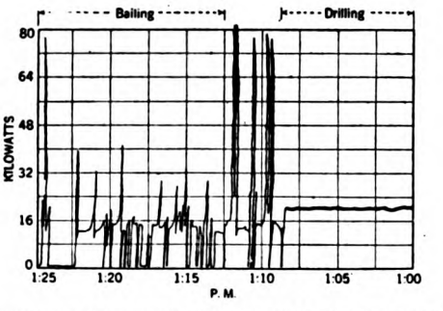

FIG. 2. CURVE OF POWER DEMAND IN DRILLING AND BAILING.

While electric motors are used to some extent for drilling with cable tools, and even for drilling with a rotary outfit, most of the motors in the oilfields are used on producing wells for pumping, cleaning, pulling tubing, etc. The size of motor needed for pumping is determined by general practice, rather than by theoretical considerations. The following is a summary of records from over 200 wells in the California fields:

Depth of wells	900 to 3100 ft., average 1430 ft.
Length of stroke	29 to 32 in.
Strokes per minute	20 to 30, average 24
Diameter of tubing	3 in.
Power required	1 to 5 hp., average 3.5 to 4 hp.

Exceptional wells in California have required as high as 16 to 17 hp. at times. In Louisiana some heavy pumping wells have been encountered, one in the Evangeline field requiring the following:

Depth, ft.	1000
Length of stroke, in.	30.5
Strokes per min.	40
Diameter of tubing, in.	2.5
Power required, hp.	9.5

Another Louisiana well in the Caddo field gave test results as follows:

Depth, ft.	1000
Length of stroke, in.	37.5
Strokes per min.	38
Diameter of tubing, in.	3
Power required, hp.	17.5

The following formula is suggested for computing the power required for pulling tubing and rods, and is based on the assumption of a mechanical efficiency for the rig of 50%:

$$\text{hp.} = \frac{W \times d \times N}{63{,}000 \times L}$$

in which W = weight lifted in pounds.
d = diameter of bull-wheel shaft in inches.
N = rev. per min. of bull-wheel.
L = number of lines used in the tackle.

Swabbing a well sometimes results in a peak load as great as 70 kilowatts. The total monthly power consumption for a producing well, including pumping, pulling rods, etc., ranges between 1350 and 6000 kilowatt-hours, with an average of about 2100.

Slip-ring induction motors are nearly always used for a producing well. These are of the Y-delta or the two-speed type. In some cases, one motor is used for pumping a well, and a separate portable motor and outfit serves for pulling tubing and cleaning several wells. While this allows each motor to be designed especially for the particular work it is to do, most operators find it more convenient to use a single stationary motor for all purposes. Where a separate portable motor is used it may be coupled to a hoist mounted on a truck, or the motor alone may be portable and designed to be belted to the countershaft at each well.

Motors are also used in connection with pumping-jacks. This system requires 2.5 hp. per well per day on an average, a considerable saving over individual operation. Jacks are, however, seldom used except when the production per well is comparatively low, since it is impossible to pump each well at the most advantageous speed.

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The Lindsay-Strathmore Irrigation District*

The Lindsay-Strathmore irrigation district comprises about 16,000 acres of land along the western slope of the foothills of the Sierra Nevada mountains in the vicinity of Lindsay, Tulare county, California. About half of the land within the district is irrigated at the present time from individual wells and pumping plants. The irrigated land is mainly devoted to citrus crops, for which it is particularly suited, since it has the advantage of the warm and practically frostless climate that is characteristic of a narrow belt lying along the eastern side of the great valley of California directly adjoining the Sierra foothills. The land in the district varies from 350 ft. to 700 ft. above sea-level. Except for a few hundred acres in the higher part of the district, the slope ranges between 15 and 40 ft. to the mile.

In order to increase the present water-supply and to extend the irrigated area, the land-owners formed an irrigation district under the amended Wright Act, and employed Stephen E. Kieffer of San Francisco, to prepare plans for an irrigation system. Bids for the construction of the system were opened in August and the contract awarded to James Kennedy, of Los Angeles, for $1,231,240.47, the contractor agreeing to take the bonds of the district at par and the nominal premium of $10 for the entire amount. Shattuck-Edinger Co. bidding with the Contra Costa Construction Co. bid $1,265,353 and offered 91.13 for the bonds. McClenahan-Kraner-Carter Co. bid $1,155,131, and offered 90.75 for the bonds. On account of the higher price offered for the bonds, the Kennedy bid was really the lowest.

The proposed system comprises 37 wells to be drilled on a tract of land adjacent to the Kaweah river, a wood-stave pipe collecting system from the wells, two 48-in. wood-stave mains about four miles long, about 13 miles of concrete-lined canal and bench-flume, and a distribution system of riveted-steel pipe, ranging in size from 36 in. down to 4 in. diameter.

The wells are to be started with 18-in. casing and finished with 16-in. to an average depth of 100 ft., penetrating a thick stratum of water-bearing gravel. It is estimated that not less than 1000 gallons per minute can be safely pumped from each well. Each well is to be provided with a deep-well vertical centrifugal turbine pump with a capacity of 1000 gallons against a total head of 100 ft., consisting of 25 ft. below the top of the well-casing, and an approximate head of 75 ft. above this point. The pumps are to be direct-driven from a vertical 40-hp. motor with an operating speed at full load not exceeding 1170 r.p.m. The available current is 60-cycle, 3-phase, and is to be obtained from a Mt. Whitney Power & Electric Co. substation to be constructed on the tract. The voltage is 2400.

*From data furnished by Stephen E. Kieffer, consulting engineer, 57 Post street, San Francisco.

The collecting system from the wells is composed of wood-stave pipe ranging from 14 to 48-in. diam. From the corner of the tract, at elevation 400, two 48-in. wood-stave mains will extend 20,300 ft. to a junction with the present main canal of the Foothill Ditch Co. at elevation 460. This canal will be enlarged, the alignment improved, and lined with concrete reinforced with 1½-in. mesh of No. 19 wire. It will be 6 ft. wide on the bottom with 1:1 slopes and will run water 3 ft. deep. The estimated capacity is 85 cu. ft. per second.

This 'low-level' canal is 31,600 ft. long, and extends to the main pumping station near the northern end of the district, at elevation 447. This station is to have three 18-in. single-stage horizontal centrifugal pumps, each with a capacity of 10,000 gallons per minute, direct-connected to 500-hp. motors, one 12-in. pump, capacity 4000 gallons per minute, with a 200-hp. motor, and two 8-in. pumps, capacity 2000 gallons per minute, with 100-hp. motors. The suction lines from the canal are to have a drop of 6 in. toward the pumps. The total delivery head including friction is about 160 ft. There are two 36-in. riveted-steel discharge pipes approximately 1100 ft. long, delivering water to 'high-level' ditch No. 1, at an elevation of 600 ft. In case of a stoppage of the pumps, the excess water is delivered through a 30-in. plain concrete waste-pipe to an earth reservoir covering 3.15 acres and having a capacity of 7,500,000 gallons.

The so-called high-level ditch No. 1 is to be a reinforced concrete bench-flume, 4 ft. wide and running water 3 ft. 6 in. deep. On account of steeper grade, its capacity will be the same as the low-level ditch. Riveted-steel distributing mains take out of the flume at various points. The total length of the flume is 29,800 ft. It empties into two riveted-steel pipe-lines, main lines No. 1 and 2. Main line No. 1 is 36 in. diam. at the beginning. It extends south and then east through the lower land of the district, the size being reduced gradually. Main line No. 2 extends four miles to the booster station to 'high-level' ditch No. 2. The diameter ranges from 30 down to 26 inches.

The booster station is to be equipped with one 8-in. horizontal single-stage centrifugal pump, direct-connected to a 125-hp. motor and having a capacity of 2130 gallons per minute, one 7-in. pump, with 75-hp. motor and a capacity of 1280 gallons per minute, and one 6-in. pump, with a 50-hp. motor and a capacity of 850 gallons per minute. The total delivery head, including friction is 160 ft. The pumps are placed with a fall to the suction, as with the main pumping-station. The discharge pipe is of riveted steel, 20 in. diam. and 2000 ft. long. It delivers water to 'high-level' ditch No. 2, which will have a capacity of 10 cu.

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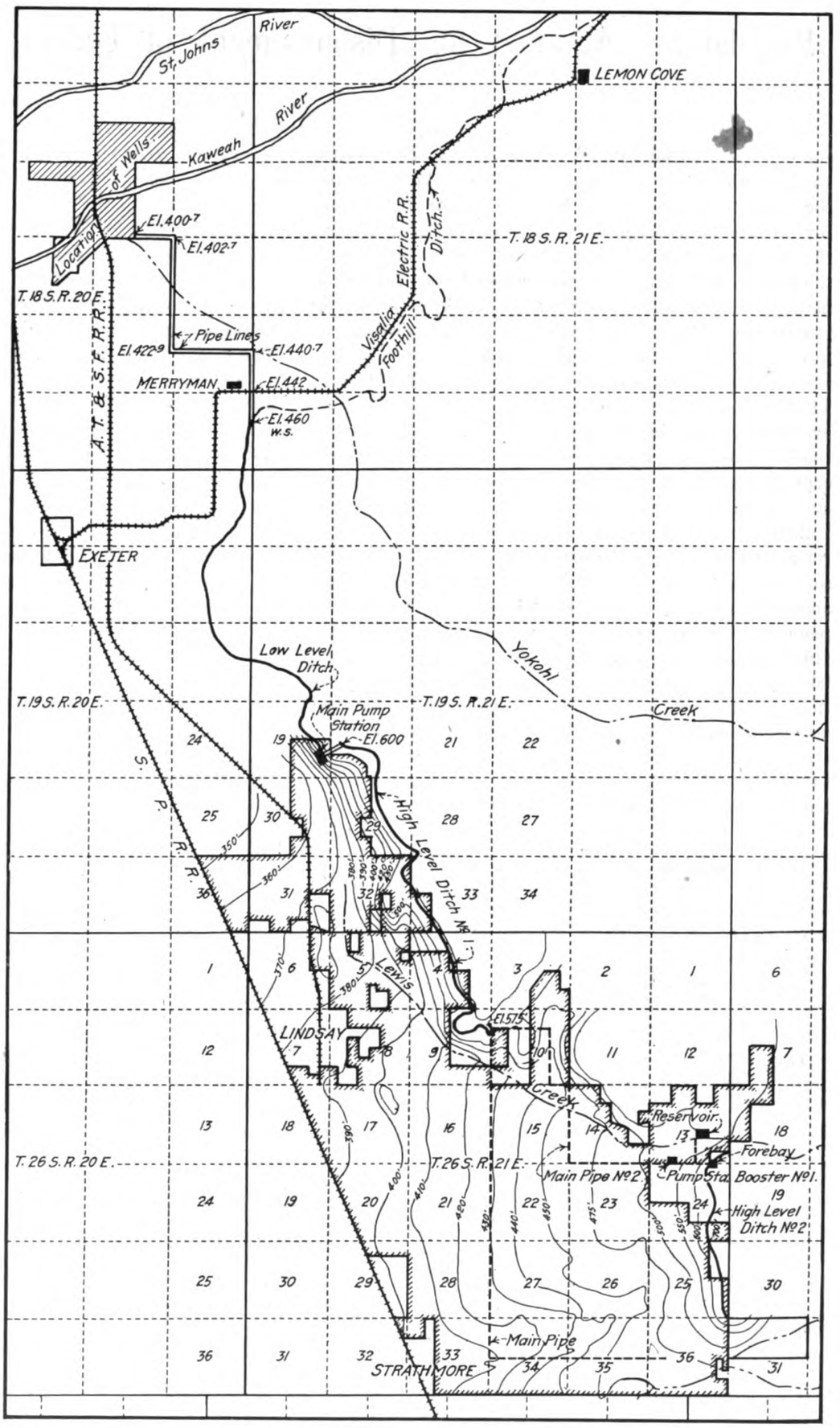
ft. per second, and will serve the highest portion of the district.

Based on the contract price, the total cost of the system per acre irrigated will be about $80. This high cost is justified by the unusually valuable crops that are raised upon the land.

OIL COOLING FOR GAS-ENGINES

Water boils at 212° F. and freezes at 32°. A good oil suitable for this work will boil at approximately 400° F. and will not freeze until the temperature falls to zero. Other things being equal, it would seem that oil would be superior to water as a cooler for gas-engines. It is, however, used only to a limited extent for this work, but has been used with marked success in many of our farm tractors.

In order to use oil, a pump in the circulation system is required, as the thermosiphon is not rapid enough. During cold weather oil has a decided advantage over water. It will not freeze and crack the radiator and at high temperatures it does not evaporate as rapidly as water. It is, however, at a slight disadvantage as compared with water in that it is not quite as good a conductor of heat. This makes it necessary to have a good sized circulating pump in order that the same amount of cooling may be obtained.—E. B. House, Colorado Experiment Station.



MAP OF LINDSAY-STRATHMORE IRRIGATION DISTRICT.

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Regulations Adopted for Disbursement of Federal Road Funds

Circular No. 65 of the United States Department of Agriculture, contains the complete text of the so-called Federal Aid Road Act (House Bill No. 7617), and also the regulations adopted by the Secretary of Agriculture for disbursing funds under this Act. The first part of the Act provides for the expenditure of $5,000,000 by the Federal Government on 'rural post-roads' during the fiscal year ending June 30, 1917, the amounts increasing yearly until $25,000,000 is to be expended during the year ending June 30, 1921, the total amount to be expended during the five-year period being $75,000,000. The term 'rural post-road' is defined as any public road over which mail is transported, excluding streets and roads in towns having a population exceeding 2500, except the portion of such streets or roads where the average distance between houses is more than 200 feet.

After deducting 3% for administrative expenses, the remainder of the appropriation is to be expended in the several States, conditional upon each State expending an amount on each project equal at least to the amount expended by the Federal Government. It is further provided that the Government's share shall not exceed $10,000 per mile, exclusive of the cost of bridges of more than 20 ft. clear span. Except for these regulations, and a provision regarding the method to be used in determining the share of each State, the expenditure of the funds appropriated is left almost entirely in the hands of the Secretary of Agriculture.

Section 8 of the Act provides for the expenditure of $1,000,000 per year for ten years on roads and trails in the National Forests, and in co-operation with local authority. Except for a provision that the total expenditure in any State, Territory, or county shall not exceed 10% of the total value of timber and forage resources in the National Forests within the county or counties, the expenditure of the funds appropriated is also left to the discretion of the Secretary of Agriculture.

The regulations laid down by the Secretary of Agriculture for carrying out the provisions of the Act are therefore nearly if not quite as important as the Act itself. They include rules for the State Highway Departments to follow in preparing information regarding any particular road project, including maps, estimates, and samples of materials which it is proposed to use in the construction of the roads. The general administration is to be in the hands of the U. S. Office of Public Roads and Rural Engineering. The State is to bear the entire cost of surveys prior to construction, procuring right-of-way, and advertising for bids. Information regarding the entire procedure leading to the award of contracts is to be furnished promptly to the Office of Public Roads. If a contract is awarded to any but the lowest responsible bidder, the Federal Government is not liable for more than its share of such bidder's offer. Unless expressly stipulated to the contrary, materials of construction must be tested in accordance with the methods of the Office of Public Roads. Bridges shall have a clear width of 16 ft. in the clear and a clear head-room of 14 ft. for 8 ft. in the centre. No part of the Federal appropriation is to go toward the payment of royalties for any patented device unless such patented device was purchased in open bidding at the same or a lower cost than other unpatented articles that are equally suitable. Each State Highway Department is made responsible for the inspection of the work during construction. A fund of 10% is to be deducted for engineering and contingencies. Rules are given for keeping records of costs and other construction information.

The administration of the funds for forest roads is also in the hands of the Office of Public Roads. A distinction is made between a National Forest road and a co-operative road. A National Forest road is defined as a road constructed in co-operation with the local authorities under the direct supervision of the Secretary of Agriculture and paid for wholly or in part from funds made available under the Act. Maintenance of such roads will generally be supervised by the Office of Public Roads. In general, the local authorities will be required to pay at least 50% of the cost of construction and the entire maintenance cost, but this may be reduced for any particular project by the Secretary of Agriculture. This payment or co-operation may be in the form of money, labor, or materials, or in the construction of co-operative roads. A road is considered a co-operative road when it connects with a National Forest road in such a way as to form a link between it and the general State, Territory, or county road system. A co-operative road may be either within or without National Forest boundaries. The cost of construction and maintenance of co-operative roads is to be borne by the local authorities but such construction and maintenance is to be subject to the inspection and approval of the Office of Public Roads. Applications for Federal funds under this portion of the Act are to be prepared in much the same manner as for the general roads. The Forest Service is to examine and report upon projects to the Secretary of Agriculture. Ten per cent of the amount available each year is to be withheld for a contingent fund. The method to be employed in dividing the funds among the States is given, but the specified amounts may be increased by the Secretary of Agriculture if deemed advisable, using the contingent fund for this purpose. Regulations regarding accounting are also given.

Applications for Federal aid for roads to be constructed during the fiscal year ending June 30, 1917 are to be filed on or before October 1, 1916, and for each succeeding fiscal year, on or before the first day of January next preceding such fiscal year.

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Summary of Bids for Construction of Sanitary Sewer System at Fresno, California

The following bids were received on September 5 for the construction of a system of sanitary sewers, or rather an extension of the present system, at Fresno, California. Sewage is discharged on a sewer farm several miles west of the city, and disposed mainly by broad irrigation. The present system has been enlarged from time to time, but is now inadequate to the growing needs of the city. The country is level so that none of the trenches will be deep, and all the excavation will be in earth. Contract for the work has been awarded to the Coast Construction Co. of Los Angeles, for $332,041.25, using cement pipe for the small sewers and monolithic concrete for the large sizes. B. E. Cronkhite is city engineer, and Olmstead & Gillelen, of Los Angeles, are consulting engineers. It will be remembered that in the report of the consulting engineers, an abstract of which was published in WESTERN ENGINEERING, for May, an estimate of $425,322 was given for the cost of the system. This, however, included engineering and inspection, and was admittedly liberal. A bond issue of $500,000 for the construction of the system as well as a system of storm sewers has been voted. The consulting engineers estimated the total cost of both systems, including engineering and inspection at $591,428. Judging from the bids on the sanitary-sewer system, it seems probable that both systems can be constructed for the amount of the bond issue. A call for bids for the construction of the storm sewers will not be issued until next year. An area of about 330 acres in the central part of the city will be served by the proposed storm-sewers.

The work was divided into two sections and the total bids were as follows:

(1) Coast Construction Co., Los Angeles, section No. 1, $93,224.05; section No. 2, $238,817.20; total, $332,041.25.

(2) James Kennedy, Los Angeles, section No. 1, $95,007.68; section No. 2, $259,757.70; total, $354,765.38.

(3) Bent. Bros., Los Angeles, section No. 2, $275,225.40.

(4) Clinton Construction Co., San Francisco, section No. 2, $287,402.

(5) Shea, Scoggins & Elliott, Portland, Oregon, $103,821.94; section No. 2, $298,006.30; total, $401,828.24.

(6) T. J. Shea, Los Angeles, section No. 1, $112,524.45; section No. 2, $316,752.50; total, $429,276.95.

(7) John Radich, Los Angeles, section No. 1, $95,554.40; section No. 2, $328,057; total, $423,611.40.

(8) Tibbitts-Pacific Co., San Francisco, section No. 1, $72,801.70; section No. 2, $334,318; total, $407,119.70.

(9) Gibbons, Reed & Roche, Salt Lake City, section No. 2, $344,903.10.

(10) Federal Construction Co., San Francisco, section No. 1, $121,796.23; section No. 2, $373,592.60; total, $495,388.83.

(11) Eggert & Tomich, Los Angeles, section No. 1, $106,186.70.

(12) Chambers & Heafey, Oakland, section No. 1, $114,557.75.

The bid of the Coast Construction Co. was conditional upon its being awarded the entire work.

Section No. 1	1	2	5	6	7	8	10	11	12
2940 ft. 16-in. vitrified pipe per ft.	$2.60	$2.30	$2.35	$2.25	$2.00	$1.60	....	....	$1.40
2940 ft. 16-in. cement	2.52	2.30	....	2.25	2.00	....	$3.61	$2.90	1.48
4068 ft. 20-in. vitrified	2.94	3.31	2.78	3.50	2.50	2.20	....	....	2.54
4068 ft. 20-in. cement	2.74	2.89	....	3.30	2.50	....	3.77	3.35	2.20
2892 ft. 24-in. vitrified	3.39	4.09	3.45	4.85	3.20	2.75	....	....	3.62
2892 ft. 24-in. cement	2.30	3.34	....	4.40	3.20	....	....	....	2.99
2892 ft. 24-in. reinforced concrete	2.61	3.77	....	4.65	3.20	....	4.25	3.70	3.04
2892 ft. 24-in. common brick	....	3.02	....	4.40	....	....	....	3.50	....
5858 ft. 27-in. cement pipe	3.85	4.28	4.00	5.00	3.50	....	....	....	4.75
5858 ft. 27-in. reinforced concrete	3.94	4.41	4.00	5.50	3.60	....	4.90	4.00	4.55
5858 ft. 27-in. common brick	....	3.56	....	5.00	....	2.75	....	4.00	....
5858 ft. 27-in. monolithic	....	3.41	....	4.00	3.50	2.75	....	....	5.05
9143 ft. 30-in. cement pipe	3.25	4.95	....	....	4.00	....	....	....	5.90
9143 ft. 30-in. reinforced concrete	4.18	5.07	4.45	....	4.15	....	4.69	4.30	5.75
9143 ft. 30-in. common brick	....	4.23	....	4.00	....	2.80	....	4.00	....
9143 ft. 30-in. monolithic	....	4.08	....	....	4.00	2.80	....	....	6.30
9143 ft. 30-in. radial brick	....	6.41	....	....	....	....	....	....	....
1580 ft. 36-in. reinforced concrete	4.71	5.76	5.15	7.00	7.10	....	6.54	6.54	6.38
1580 ft. 36-in. common brick	....	7.80	....	....	....	....	....	....	....
1580 ft. 36-in. monolithic	4.31	5.13	....	....	7.00	4.50	....	....	7.10
1580 ft. 36-in. radial brick	....	5.56	....	....	....	....	....	....	....
47 manholes, brick	73.00	50.00	50.00	60.00	45.00	50.00	54.00	54.00	70.00
47 manholes, concrete	...	50.00	....	60.00	....	....	....	....	70.00

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Section No. 2	1	2	3	4	5	6	7	8	9	10
3,800 ft. 42-in. reinforced concrete pipe, per ft.	$5.65	$6.24	$6.50	....	$7.43	$7.60	$9.00	....	$9.25	$8.00
3,800 ft. 42-in. common brick	...	7.91	....	....	....	....	....	....	....	....
3,800 ft. 42-in. monolithic concrete	5.21	5.55	6.50	7.35	....	7.60	8.80	$7.75	....	....
3,800 ft. 42-in. radial brick	...	6.76	....	....	....	....	....	....	....	....
3,500 ft. 48-in. reinforced concrete	6.51	8.22	7.50	....	8.10	9.15	10.00	....	10.00	8.75
3,500 ft. 48-in. common brick	...	9.89	....	....	....	....	....	....	....	....
3,500 ft. 48-in. monolithic concrete	6.15	7.14	7.50	7.45	....	9.15	9.75	8.25	....	....
3,500 ft. 48-in. radial brick	...	8.25	....	....	....	....	....	....	....	....
2,662 ft. 54-in. reinforced concrete	8.11	12.00	9.50	....	8.73	11.25	15.00	....	13.35	13.60
2,662 ft. 54-in. common brick	...	13.05	....	....	....	....	....	....	....	....
2,662 ft. 54-in. monolithic concrete	7.90	10.61	9.50	10.50	....	11.25	14.80	14.50	....	....
2,662 ft. 54-in. radial brick	...	11.76	....	....	....	....	....	....	....	....
22,428 ft. 60-in. reinforced concrete	8.28	9.75	8.80	....	9.68	10.00	10.00	....	10.00	12.30
22,428 ft. 60-in. common brick	...	10.71	....	....	....	....	....	....	....	....
22,428 ft. 60-in. monolithic concrete	7.90	8.21	8.80	9.08	....	10.00	9.80	10.50	....	....
22,428 ft. 60-in. radial brick	...	9.55	....	....	....	....	....	....	....	....
20 manholes, brick	73.00	50.00	75.00	75.00	50.00	80.00	45.00	50.00	7.00	60.00
20 manholes, concrete	73.00	50.00	75.00	....	....	70.00	45.00	....	7.00	....
3 culverts	66.00	50.00	140.00	300.00	150.00	300.00	400.00	900.00	150.00	300.00

Sterilization of Water with Chlorine and Hypochlorite*

Treatment of water supplies with chlorine to destroy harmful bacterial life has been a common practice of recognized merit for approximately ten years. This chemical was first used in the form of calcium hypochlorite, or common chloride of lime, the powder being dissolved in water and fed as a solution into the water supply. More recently the use of chlorine gas has come to be recognized as often having advantages over the hypochlorite treatment and has been rapidly supplanting the old method. Chlorine is obtainable compressed to liquid form in cast-iron cylinders. There are several machines on the market for feeding the gas accurately into a water supply. Notwithstanding a rather general impression that hypochlorite treatment is somewhat out of date, it is preferable to liquid chlorine in some cases.

Comparisons of Hypochlorite and Liquid Chlorine Treatment

Effectiveness. Treatment with either hypochlorite or liquid chlorine is effective in sterilizing water. In either case it is merely a question of introducing the requisite quantity of chemical and of doing this continuously at a uniform rate.

Taste. Where hypochlorite has been used, complaints of tastes in the water have been frequent. On this account it is highly important that overdosing of the water be avoided. Difficulty in regulation of the hypochlorite solution feed between the critical limits of overdosing and underdosing constitutes one of the objectionable features of this method. In the case of liquid chlorine, complaints due to taste are rare, and overdosing is permissible, at least, to a considerable extent.

Convenience. Hypochlorite treatment has the disadvantage that the powder emits penetrating odor that irritates the nostrils and throats of men working with it. Aside from the inconvenience thus resulting to the men, this feature is apt to impair the efficiency of the treatment indirectly as a result of the men developing a natural tendency to avoid giving the treatment proper attention. With liquid chlorine the gas rarely escapes into the open air.

Cost of Equipment. In point of first cost, hypochlorite treatment has an advantage over liquid chlorine. A device for applying hypochlorite should not cost over $100, for a water system supplying up to, say, 5000 people. A liquid-chlorine machine to serve the same purpose would cost probably not less than $450 in California.

Cost of Operation. The cost of chemical for either form of treatment is a small item and in either case is about the same, amounting at present to about forty cents per million gallons of water treated.

Emergency or Temporary Use. It sometimes happens that immediate disinfection is necessary. In this case a delay of possibly several weeks in ordering and awaiting shipment from the East of liquid chlorine apparatus is undesirable. A hypochlorite plant for such emergency use can usually be built of material at hand, and by its use this delay can be avoided. Also, in some cases only temporary or intermittent treatment is necessary, in which case the extra financial outlay for liquid chlorine equipment is not warranted, and the disadvantages of hypochlorite treatment are counter-balanced by the saving in cost.

Except for brief or emergency treatment, chloride of lime purchased at a local store is not to be recommended for use, as this material usually is far below standard strength. If the treatment is to be continuous the chemical should be purchased from reliable houses in sealed drums of ten pounds or more. Unused hypochlorite should be kept dry and in a closed container

*Abstract of article by Ralph Hilscher in Bulletin of California State Board of Health.

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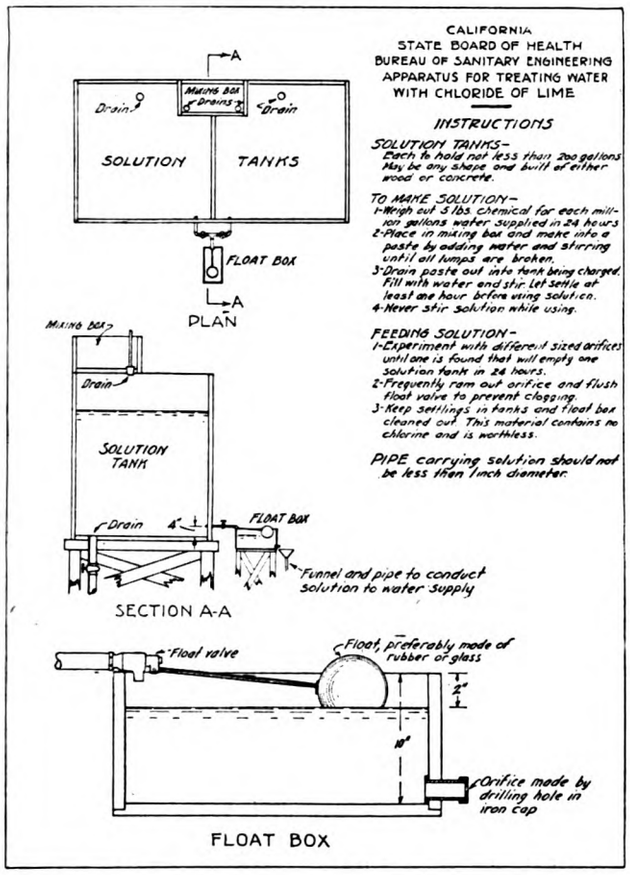
in order to prevent the chlorine from escaping. A dose of five pounds of hypochlorite per million gallons of water is usually sufficient to effect satisfactory bacterial removal, and, at the same time, avoid taste in the water, provided the chemical is of good quality. The accompanying sketch is prepared on the assump-


CALIFORNIA
STATE BOARD OF HEALTH
BUREAU OF SANITARY ENGINEERING
APPARATUS FOR TREATING WATER
WITH CHLORIDE OF LIME
INSTRUCTIONS
SOLUTION TANKS—
Each to hold not less than 200 gallons
May be any shape and built of either
wood or concrete.
TO MAKE SOLUTION—
1-Weigh out 5 lbs. chemical for each million gallons water supplied in 24 hours
2-Place in mixing box and make into a paste by adding water and stirring until all lumps are broken.
3-Drain paste out into tank being charged. Fill with water and stir. Let settle at least one hour before using solution.
4-Never stir solution while using.
FEEDING SOLUTION—
1-Experiment with different sized orifices until one is found that will empty one solution tank in 24 hours.
2-Frequently ream out orifice and flush float valve to prevent clogging.
3-Keep settlings in tanks and float box cleaned out. This material contains no chlorine and is worthless.
PIPE carrying solution should not be less than 1 inch diameter.
A
Mixing Box
Drain
Drain
SOLUTION TANKS
FLOAT BOX
A
PLAN
Mixing Box
Drain
SOLUTION TANK
Drain
4"
FLOAT BOX
Funnel and pipe to conduct solution to water supply
SECTION A-A
Float valve
Float, preferably made of rubber or glass
2"
10"
Orifice made by drilling hole in iron cap
FLOAT BOX

SKETCH OF STERILIZING APPARATUS.

tion that attention only once a day is practicable. Ordinarily the smallest orifice feeding the solution and giving good regulation will flow 200 gallons per day. Each tank should therefore hold at least this volume. More frequent attention is advisable, in order to prevent clogging of orifices or pipes in the apparatus.

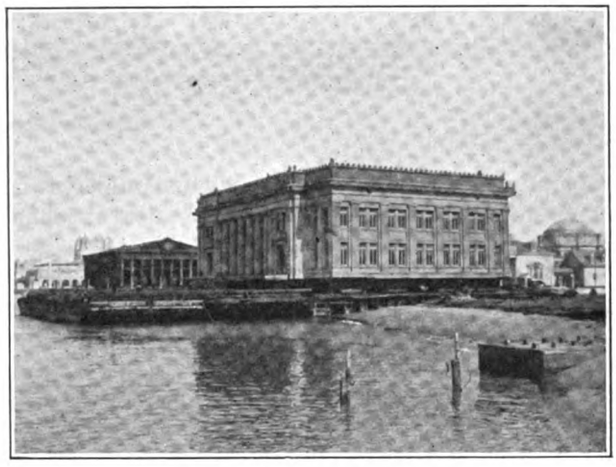
Glassware for chemical purposes, equal to the famous Jena, Germany, product, is now being made in the United States, according to Allen Rogers, of the American Chemical Society. The domestic glass is to be exhibited at the Second National Exposition of Chemical Industries at New York on September 25. Many other American products will be on view.

Holes in castings should be placed at a certain minimum distance from the edge of the casting. A drilled bolt-hole should be placed at least $1\frac{1}{4}$ times its diameter from the edge of the casting; a cored bolt-hole, $1\frac{1}{2}$ times its diameter; a drilled rivet-hole, $1\frac{3}{4}$ times its diameter; and a cored rivet-hole 2 diameters from the edge of the casting.—*Mechanical World.*

MOVING 1000-TON BUILDING ON BARGES*

An interesting feat of house-moving was recently accomplished in the transportation of the entire Ohio building intact, from the Panama-Pacific Exposition grounds at San Francisco to San Carlos on the lower bay about 25 miles distant by water. The building is 85 ft. by 133 ft. 6 in. long and weighs about 1000 tons, estimated from the water displacement of the barges. It stood about 600 ft. from the beach at the Exposition grounds. It was constructed of Oregon pine, plaster-finish inside and out, with four large brick chimneys and massive fireplaces.

One hundred and seventy jack-screws were used to raise the building, 12 by 12-in. Oregon pine timbers being first placed lengthwise under the sills of the



LOADING BUILDING ON BARGES.

building. These were crossed with timbers 16 by 16-in., under which the hardwood shoes and rollers were placed, 250 California laurel rollers being used. Six tracks built of 12 by 12-in. timbers were laid on the ground for the rollers and the building was pulled by six horses hitched to ordinary house-moving capstans, with a purchase of 10 parts of $4\frac{1}{2}$-in. manila rope to each capstan. In this way the building was hauled to the beach without difficulty.

At the beach, ways were laid and held in place by several tons of broken concrete. Two barges each 36 by 140 ft. long were floated on to the ways at high tide. Tracks were built of 16 by 16-in. timbers across the decks of the barges. The building was rolled on the barges while they were resting on the ways. At extreme high tide, the barges floated, and were towed to San Carlos by a Red Stack towboat and three gasoline tugs from the Oakland Launch & Towboat Co. The unloading was practically the reverse of the loading operation. The building is to be used as a club house by the San Francisco Peninsula Club. The entire moving was done by H. L. Hatch, house-mover and rigger, of San Francisco.

*From data furnished by H. L. Hatch, 110 Jessie street, San Francisco.

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Census Report on United States Cities

The Bureau of the Census, S. L. Rogers, director, has issued a report on 'Financial Statistics of Cities' of over 30,000 inhabitants for the fiscal year 1915. The accompanying table, taken from the report shows the per capita net payments for departmental expenses at two-year intervals from 1903 to 1915. Under departmental expenses, the Census Bureau does not include the cost of operating and maintaining municipal undertakings such as water and lighting systems, nor does it include 'municipal outlays,' which are defined as "the costs of properties, including land, buildings, and equipment, and public improvements of a more or less permanent character, which are acquired or constructed by municipalities for use in the exercise of their municipal functions or in connection with the business enterprises undertaken by them."

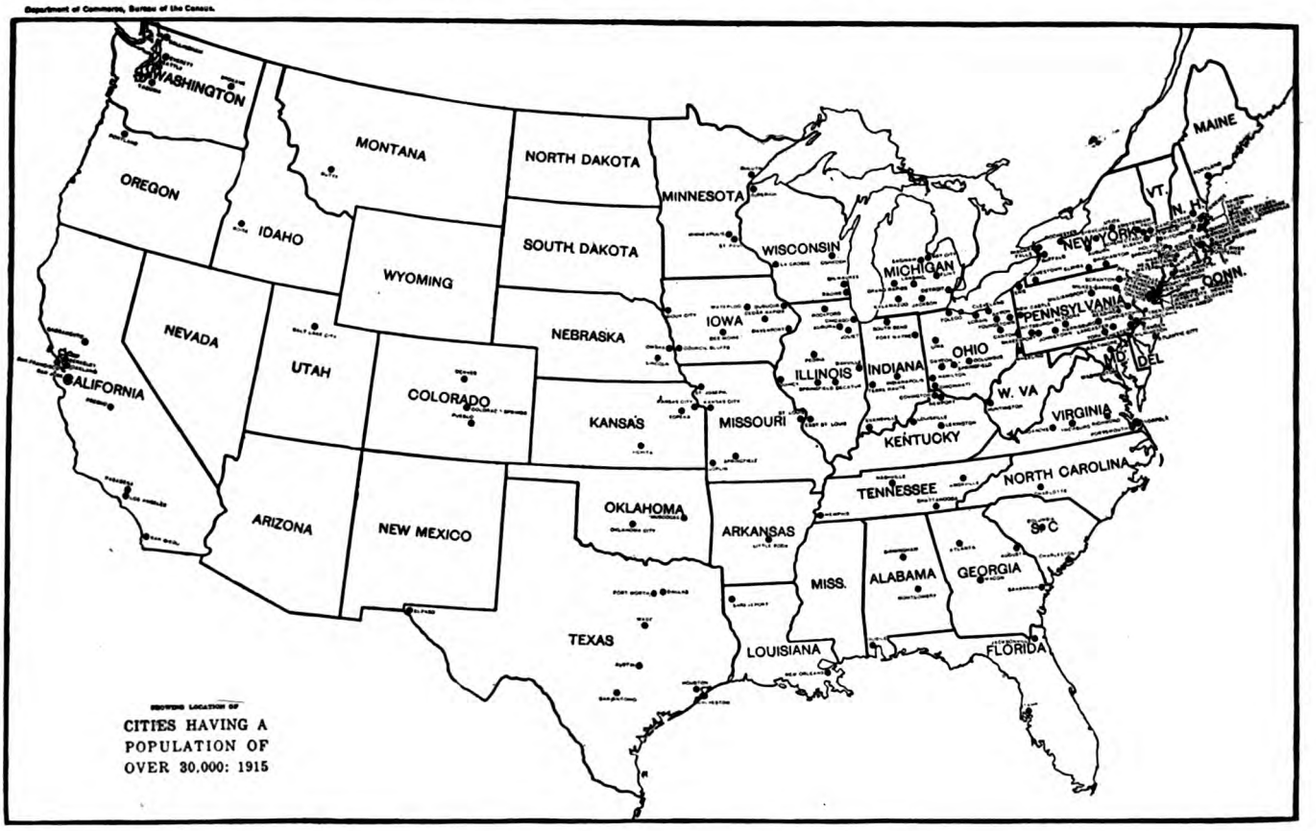
Of the 204 cities which the Census Bureau estimates had over 30,000 inhabitants in 1915, 81 had some form of commission or commission-manager government at the close of the fiscal year 1915. These commission governed cities included Berkeley, Oakland, Pasadena, Sacramento, and San Diego, California; Portland, Oregon; Everett, Spokane, and Tacoma, Washington; Boise, Idaho; and Salt Lake City, Utah.

YEAR.	Total.	General government.	PROTECTION TO PERSON AND PROPERTY.			Conservation of health.	Sanitation, or promotion of cleanliness.	Highways.	Charities, hospitals, and corrections.	EDUCATION		Recreation.[2]	Miscellaneous and general.[1]
			Police department.[1]	Fire department.[1]	All other.					Schools.[1]	Libraries.[2]		
1915	$18.45	$2.10	$2.08	$1.63	$0.35	$0.40	$1.46	$2.06	$1.26	$5.58	$0.24	$0.68	$0.61
1913	17.23	2.00	2.00	1.57	0.32	0.35	1.40	1.93	1.11	4.98	0.22	0.63	0.71
1911	17.02	2.08	2.12	1.67	0.33	0.33	1.44	2.04	1.17	5.04	0.23	0.65	0.33
1909	16.07	1.96	2.03	1.57	0.29	0.31	1.31	1.71	1.10	4.54	0.25	0.55	0.45
1907	15.95	1.86	1.98	1.53	0.29	0.29	1.30	1.91	1.05	4.42	0.21	0.51	0.59
1905	13.88	1.38	1.85	1.40	0.27	0.22	1.13	1.67	0.88	3.99	0.19	0.47	0.44
1903	13.19	1.46	1.80	1.30	0.25	0.22	0.99	1.64	0.86	3.86	0.19	0.35	0.27

[1] Payments for pensions are included in column "Miscellaneous and general" for 1911, 1913, and 1915; for the years 1903 to 1909 they are included with expenses of the police, fire, and school departments.
[2] Payments for expenses of art galleries and museums are included in column "Recreation" for 1911, 1913, and 1915; for the years 1903 to 1909 they are included with the expenses of libraries.

TABLE OF MUNICIPAL EXPENDITURES.

Increased efficiency in the Census Bureau is shown by the fact that while the volume of Financial Statistics of Cities for 1909 was not ready for the printer until December 1912, and became available for distribution on February 20, 1913, the volume for 1915 was ready for the printer on February 14, 1916. On account of an unusual amount of work ahead in the Government printing office, however, the report was delayed in printing and could not be made available for public distribution until August 7, 1916.



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Timber Framing—Part V

By HENRY D. DEWELL*

Intermediate Joints of Trusses

An intermediate joint in a truss differs from the end joint only in the smaller stresses to be considered, and in the existence of a length of adjacent chord sufficient to take the component of the diagonal stress in the web by longitudinal shear in the timber. The discussion of the end joints of Types A and B will therefore apply in principle to all other joints of the typical truss shown, if the tension of the rod at the panel point be substituted for the end reaction. Details of intermediate joints in roof trusses furnish a good indication of the extent of the designer's knowledge of structural mechanics. Frequently, and especially where the truss is counterbraced in the central bays, the opposing diagonals are merely butted against one another with no provision for transmitting the component of the diagonal stress to the chord.

Fig. 28, 29, and 30 illustrate three methods of detailing the joints at panel points No. II and IV of the English roof truss of Plate VII of Part IV. Of these details, the two shown in Fig. 28 and 29 are the most common. The detail of Fig. 30 is seldom used; nevertheless it is the most consistent and logical in principle, and the simplest of construction of the three types shown. This statement can best be brought out by a detailed discussion of the three types.

Type A, Fig. 28. Since neither of the two bearing surfaces of the indent is normal to the longitudinal axis of the strut, both surfaces exert a pressure on the chord, which can be determined by resolving the stress in the member, 11,500 lb., into two components, perpendicular, respectively, to the planes of the two bearing surfaces. The angle which each bearing plane makes with the direction of fibres of the timber determines at once the allowable unit bearing-pressure, as discussed in Part II. This unit pressure requires a certain minimum bearing-area, and the necessary depth of indent is thereby determined. Each of the two components must be investigated in this manner.

It is evident that the shape of the chord indent and the length of the two bearing surfaces can be found only by a 'cut and try' method. For example, in the present instance, the web stress, 11,500 lb., is resolved into the two components 8200 lb. and 6000 lb. The 8200 lb. component has an inclination of 30° with the direction of fibers, or the bearing plane makes an angle of 60° with the fibers. By reference to Fig. 3, Part II, the safe unit pressure for this angle is seen to be 1400 lb. per sq. in. The required bearing area is then $\frac{8200}{1400} = 5.86$ sq. in., which necessitates a depth of indent of $\frac{5.86}{6} = 1$ in. Similarly the limiting inclination of the 6000-lb. component is $12\frac{1}{2}°$, which is the angle which the bearing surface makes with the direction of fibers. The safe unit pressure for this angle is 410 lb. per sq. in. The required area for bearing for this surface is then $\frac{6000}{410} = 14.6$ sq. in., which corresponds to a length of cut of $\frac{14.6}{6} = 2.5$ in. In a similar manner, the depth of indent for panel point No. VI is found to be $1\frac{1}{8}$ in., corresponding to $\Theta = 76°$, $n = 1700$ lb. per sq. in., giving required area of 6.4 square inches.

The required angles for the cuts must be noted carefully on the plans in order to secure the conditions in the field that are assumed in the design of the joint. As each diagonal of the truss may have a different slope for its end cuts, the most careful and accurate workmanship will be necessary to secure the desired results. This type of joint therefore violates the principle that all carpenter work should be made as simple as possible.

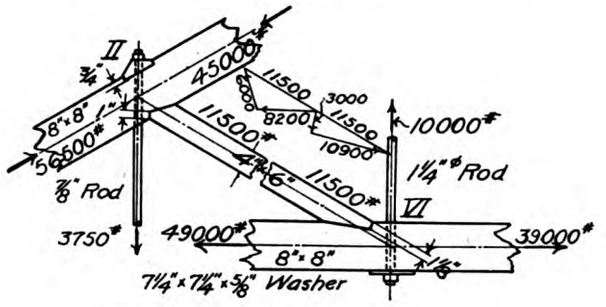

FIG. 28. INTERMEDIATE JOINT, TYPE A.

Type B, Fig. 29. In this detail, the end cuts of the struts are normal cuts. The length of the chord indents can be determined at once, since the total stress of the strut must act on the normal face of the strut alone. The conditions in this detail are exactly as discussed for the case of the Type A, end joint, in the preceding article. For panel point No. II, the angle Θ is 30°, $n = 670$ lb. per sq. in., the required area in normal cut is $\frac{11500}{670} = 17.2$ sq. in., and the required length of cut is $\frac{17.2}{6} = 2.87$ in. For panel point No. VI, $\Theta = 60°$, $n = 1400$ lb. per sq. in., the required area of cut is $\frac{11500}{1400} = 8.2$ sq. in., and the required length of cut is $\frac{8.2}{6} = 1.37$ in., or $1\frac{3}{8}$ in. The force necessary to hold the strut in equilibrium, and which must be developed by friction

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along the normal cuts of the strut will now be found. With the assumption that the thrust in the strut acts uniformly over the area of the normal cuts, the moment developed is the thrust in pounds multiplied by the eccentricity in inches, which latter is the distance between the centres of the normal bearing areas at the ends of the strut. The moment is therefore 11,500 lb. $\times$ $3\frac{3}{8}$ in. = 38,800 in.-lb. The length of the strut is approximately 153 in., therefore the force to be developed in friction is $\frac{38800}{153} = 254$ lb. This frictional force will act parallel to the normal cut of the strut. Assuming that the coefficient of friction of wood on wood is 0.20, the effective resistance may be counted upon as amounting to 0.20 $\times$ 11,500 lb. = 2300 lb. In addition to this frictional force, such joints should be always well toe-nailed. Two 16D nails will give a resistance of 256 pounds.†

Both of the details of Fig. 28 and 29, involve a considerable depth of cut into the chord. In the upper chord, theoretically, the indent is of no consequence, since the chord is in compression, and a tight joint is assumed; actually, however, there is a considerable loss in efficiency. In the lower, or tension chord, the depth

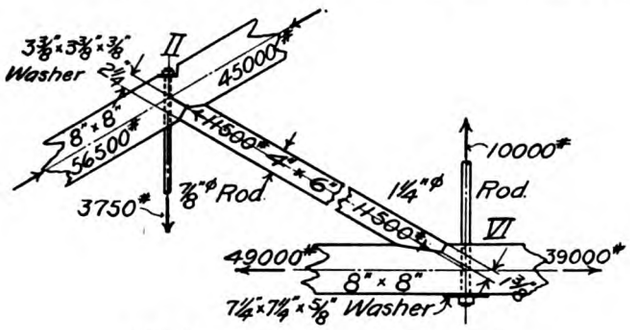

FIG. 29. INTERMEDIATE JOINT, TYPE B.

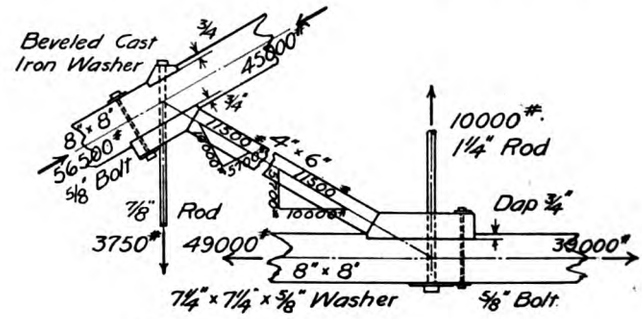

FIG. 30. INTERMEDIATE JOINT, TYPE C.

of cut is important, so that any detail reducing the depth of indent is to be favored.

There is also some eccentricity in the action of the various forces around the panel points in both details. For example, in Fig. 29, panel point No. VI, the horizontal component of the thrust of the strut acts at the centre of the toe, while the resultant tension in the lower chord acts at the centre of the uncut depth of chord. The moment of this couple is therefore (49,000 lb. – 39,000 lb. = 10,000 lb.) $\times$ $3\frac{3}{8}$ in. = 33,375 in.-lb. The vertical component of the stress in the strut is 6000 lb., and also may be taken as concentrated at the centre of the toe. This force forms a couple with the tension in the vertical rod (10,000 lb.) less the concentration at the panel point (4000 lb.), or a resultant tension of 6000 lb. The amount of the couple is therefore 6000 lb. times the horizontal distance between the centre of the rod and the centre of the normal cut on the strut, or 6000 lb. $\times$ $3\frac{3}{4}$ in. = 22,500 in.-lb. These two moments are in opposite direction of rotation, therefore the resultant moment is 33,375 in-lb. – 22,500 in.-lb. = 10,875 in.-lb. The net section of the chord, taking out the hole for the rod and the dap in the chord, is 6 in. wide by $6\frac{5}{8}$ in. deep = 39.7 sq. in. The net section modulus is $\frac{1}{6} \times 6$ in. $\times$ $(6\frac{5}{8}$ in.$)^2 = 43.8$. The resultant tension in the chord is therefore $\frac{49000}{39.7} + \frac{10875}{43.8} = 12{,}350$ lb. + 248 lb. = 12,598 lb. per sq. in. While the secondary stress is negligible in this case, it does not follow that it can always be ignored, and any truss designed for high unit working-stresses should have its joints investigated for secondary stresses. It should also be borne in mind that any variation in the relation of the web members meeting in a panel point, resulting from careless detailing or framing may increase these secondary stresses to a considerable amount.

In roof trusses employing details of intermediate joints of Types A and B, it will often be found that, with the condition of the centre lines of all members meeting at a common point satisfied, the toes of the struts will either bear against the rod, or the hole for the rod will cut away part of the strut. Sometimes this condition cannot be avoided if the strut is to be dapped into the chord. If it so happens that the rod has not a driving fit in the chord, which condition will usually exist, especially with an upset rod and a deep chord, the toe of the strut will have bearing against the chord for only a part of its width. The result of this condition will be that the actual bearing area may not be over one-half of what was assumed in design, and the unit bearing stress may consequently be double the allowable.

Type C, Fig. 30. The disadvantages of details of intermediate joints of Types A and B, as shown in the preceding paragraphs are lacking in the detail of Type C, illustrated in Fig. 30. In this joint, the strut has a full bearing on the butt block, and the butt block, in turn, utilizes the total width of the chord for bearing. Also, the detail takes advantage of the full bearing pressure in end compression of the butt block on the chord, resulting in a minimum depth of cut into the chord. Nearly all the cuts are normal, and the others are simple. All the cuts can be easily and accurately laid out and made by the carpenter. The length of the butt block can be adjusted to fit all conditions of possible interference with other connections. Its minimum length is determined by longitudinal shear. The bolt through the end of the butt block holds the block securely in its socket. Whether there is any actual tension in the bolt

†See Part III, Safe Lateral Resistance of Nails.

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depends upon the length of the butt block. This can be determined at once by inspection. If the line of the thrust of the strut falls within the base of the block, there can be no tension in the joint. However, it is well to provide at least a $\frac{5}{8}$-in. bolt to bind the joint together thoroughly. I have used this joint in many trusses of all types, and have found it to be an extremely satisfactory detail in all cases.

In Fig. 31 alternate details of intermediate joints are illustrated. These may be used for panel points No. II and VI, using the unit bearing pressures on inclined planes in accordance with the curve recommended by Howe, and shown in Part II, Fig. 4. The lower values for bearing pressures result in deeper chord indents than for the details of Fig. 28 and 29, and also necessitate increasing the strut from a 4 by 6-in. to a 6 by 6-in. timber, in the case of Type B, in order to provide sufficient bearing area against the upper chord. The detail

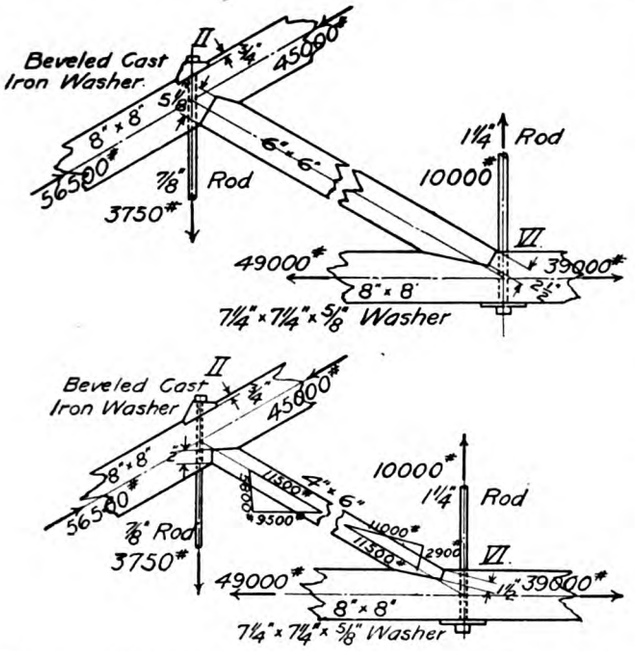

FIG. 31. INTERMEDIATE JOINTS DESIGNED BY HOWE'S FORMULA.

calculations need not be repeated, as they are similar to those made for Fig. 28 and 29.

Applying the lower bearing pressures to the butt block detail, or Type C, it will be found that the 4 by 6-in. strut must be replaced by a 6 by 6-in. strut, in order to provide sufficient bearing area for the inclined cut of the butt block. The alternative would be to use a hardwood timber, such as oak, for the butt block.

This type of truss, with its small inclination of web struts to upper chord, will usually require attention in order that the joints may have sufficient bearing in accordance with the allowable unit working-stresses adopted.

Tension Splices

In Fig. 32 to 37 are presented details of six types of tension splices, the details shown being for the centre panel of the lower chord of the English roof truss of Plate VII, Part IV. As in the case of the end-joint details for the same truss, the calculations for the design are fully shown in the figures. In all cases, the splice is designed for only the computed stress in the chord. This fact will influence any deductions that may be made regarding the comparative economy of the different types. It will be seen that in some cases it would be impossible to increase the capacity of the splice without weakening the main member beyond the allowable limit. Most specifications provide that all splices be made of sufficient strength to develop the main section of the member spliced, regardless of the possible smaller computed stress existing in the member.

The details here shown are not presented as covering the whole field of tension splices. They do show, however, the most efficient forms of splices. Various modifications are possible, as for example, the substitution of square or rectangular keys of hardwood or metal for the shear pins for Fig. 37, the omission of the wooden splice plates of Fig. 34, and the tabling of the main member itself. For a description of the various forms of splicing timbers, including the lapped and scarfed splice, the reader is referred to the texts of Jacoby, Howe, Thayer, Kidder, and others.

The detailing of tension splices is a problem to be decided for the individual case, in conformity with the circumstances of importance of the connection, cost of materials, quality of workmanship to be expected, possibility of occasional inspection after completion, and the particular requirements of the splice. It will usually be found, however, as in the case of other truss connections, that certain details stand out as superior to the many that may be used, and that such type or types may be employed successfully for almost all the cases that will arise, with minor modifications.

For convenience of reference the details shown may be listed as follows: Fig. 32, the Bolted Fish-plate Type, Fig. 33, the Modified Bolted Fish-plate Type, Fig. 34, the Tabled Fish-plate Type, Fig. 35, the Steel-Tabled Fish-plate Type, Fig. 36, the Tenon-Bar Type, and Fig. 37, the Shear-Pin Type. The advantages and disadvantages of each type will be discussed briefly, in order that an intelligent selection may be made for any actual case.

Bolted Fish-Plate Type. The size of the bolts in this detail are computed in accordance with the formula $M = \frac{1}{2}P \times \left(\frac{t'}{2} + \frac{t''}{4}\right)$, where $t' =$ the thickness of splice pad, or fish-plate, and $t'' =$ the thickness of the main timber. As explained in Part III, this formula is that used by Jacoby and Howe, and is based on the assumption of uniform bearing of the timber along the length of the bolt. The use of this formula results in an excessive diameter of bolts being required, not only adding to the cost of the splice, but decreasing the capacity of the main timber for tension.

Besides the bending in the bolts, the net section of main timber and fish-plates must be investigated for sufficient area to resist the computed stress; the bearing

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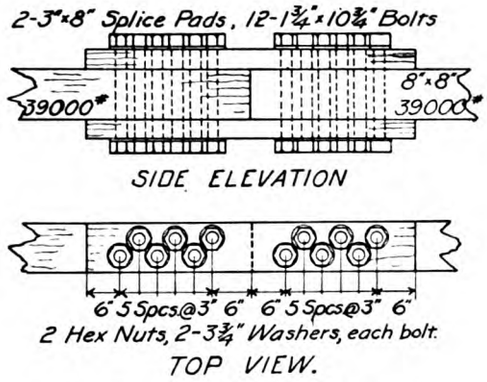

FIG. 32. BOLTED FISH-PLATE SPLICE.

COMPUTATIONS

Net area required $= \frac{39{,}000 \text{ lb.}}{1500} = 26$ sq. in.

Since the end detail required an 8 by 8-in. chord, the splice pads or fish-plates will be made 8 in. deep. Plates 2 by 8 in. are not sufficient, so use 3 by 8-in. Assuming the bolts to be $1\frac{3}{4}$ in. diameter, the net area of fish-plates will be 6 in. $\times$ [8 in. $-$ (2 $\times$ $1\frac{3}{4}$ in.)] $= 27.0$ sq. in., and the unit tension will be $\frac{39{,}000 \text{ lb.}}{27} = 1445$ lb. per sq. in. This calculation assumes the bolts spaced in pairs, and not staggered. However, with the large diameter of bolts used, the net section of chord should be figured as if the bolts occurred in pairs.

Six bolts are arbitrarily selected for each side of joint.

Bending moment on one bolt $= \frac{19500}{6} \times [(\frac{1}{2} \times 3 \text{ in.}) - (\frac{1}{4} \times 8 \text{ in.})] = 11{,}380$ in.-lb.

Required section modulus $= \frac{11380}{24000} = 0.474$ in.

$d^3 = \frac{0.474}{0.098} = 4.82$ in. and $d = 1.67$ in. Use $1\frac{3}{4}$-in. bolts.

The unit bearing pressure on the diametral section of the bolts $= \frac{39000}{1.75 \times 6 \times 6} = 619$ lb. per sq. in., which is less than one-half the allowable.

DISTANCE REQUIRED BETWEEN BOLTS

	Inches per bolt
Total shearing area required $= \frac{39000}{150} = 260$ sq. in., or	3.61
Area required for transverse tension $= \frac{39{,}000 \text{ lb.} \times 0.1}{150 \times 6 \times 6} = 0.72$	
Adding diameter of bolt	1.75
Required spacing of bolts	6.08

Use 6-in.

BILL OF MATERIAL FOR ONE SPLICE

	Pounds
Twelve $1\frac{3}{4}$ by $18\frac{1}{2}$-in. bolts at 12.6 lb	151.5
Twenty-four $1\frac{3}{4}$-in. nuts at 3.2 lb	76.8
Twenty-four $3\frac{3}{4}$-in. circular washers at 0.4 lb	10.0
Total weight of steel	238.3

Two 3 by 8-in. pieces, 4 ft. 6. in. long $= 18.0$ ft. B.M.

COST OF ONE SPLICE AS DETAILED

Steel, 238.3 lb. at $0.04	$9.55
Timber, 18 ft. B.M. at $0.04	0.72
	$10.27

BILL OF MATERIAL FOR ONE SPLICE, USING $1\frac{3}{4}$-IN. LATERAL PINS.

	Pounds
Twelve $1\frac{3}{4}$ by $15\frac{5}{8}$-in. lateral pins, at 11.37 lb. (including nuts)	137.0
Twenty-four $3\frac{3}{4}$-in. washers at 0.4 lb	10.0
Total weight of steel	147.0

Timber as before.

COST OF ONE SPLICE

Steel, 147.0 lb. at $0.04	$5.88
Timber as before	0.72
	$6.60

pressure of the timber against the bolts must not exceed the allowable unit working-stress, the distance between bolts, and also the distance between any bolt and the end of the timber, must be sufficient for longitudinal shear on the timber, and also for transverse tension. In proportioning the splice for the latter stress, it may be assumed that the transverse tension tending to split the timber along the centre line of bolts is equal to one-tenth of the longitudinal stress in the chord. The working stress for transverse tension is taken at 150 lb. per sq. in.

For determining the necessary spacing of bolts, the net distance as required by longitudinal shear in the timber is found, and to this distance is added the net length required for resisting transverse tension. To the sum of these two is added the diameter of the bolt. This combined distance is the minimum that should be used. The distance of the last bolt from the end of the timber should theoretically be one-half that of the computed bolt spacing. On account of the tendency of timber to check at the ends, those bolts in the details acting in shear, as in the splice now under discussion, have been placed a distance of six inches from the end of the timbers.

In the figure, the bolts are shown as $1\frac{3}{4}$ in. diam., and full-size nuts are indicated. If they can be obtained at a reasonable cost, standard lateral bridge-pins will be cheaper, and an alternate cost estimate has been prepared on this basis. The actual diameter of the lateral pin is $1\frac{11}{16}$ in. instead of $1\frac{3}{4}$ in. The reduction in size is not important, since it is still within the computed necessary diameter.

The disadvantages of this detail are the large sizes of bolts, with a corresponding loss in efficiency of the total splice, as has been noted. As was discussed in Part III, the general theory on which the sizes of bolts has been computed is believed to be incorrect, and such a joint would seldom be used in an actual case.‡

‡This statement needs some explanation. Where, as is the case under discussion, the pressure distribution on the bolt is assumed to be uniform, and the diameter of the bolt is then made of such a dimension that the bolt will have a resistance to bending sufficient to withstand the bending moment resulting from such uniform pressure distribution, the design cannot be said to be inconsistent, and it is believed that the action will be as assumed. Further, it may be said that no bolt of lesser diameter will give as high a total resistance per bolt of the joint. It is obvious that if the bearing of the timber on the bolt is uniform along the length of the bolt, and if the bolt is large enough to resist the resultant bending, the capacity of the joint is limited by the safe unit bearing-pressure of timber on a cylindrical metal-pin. If at the same time, the flexural strength of the bolt is attained, the infer-

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Modified Fish-Plate Type. The principles of design of this detail are the same as in the previous type, except that the sizes of bolts are proportioned from the values given in the previous article of this series. One-inch bolts have been chosen; there is no necessity for using this size as against either a smaller or larger diameter. In general, the fewer bolts there are to place, the less will be the cost of labor, and the more certain will be the combined action. Against these considerations must be weighed the amount of metal in the bolts, and the availability of the chosen size. Stock bolts are of course, cheaper than special sizes.

As the working values used here were taken from the results of tests in which the action of washers did not play a part, the splice is detailed with standard malleable washers, which will allow the joint to be drawn together fairly tightly without crushing the timbers. An estimate of an alternate detail, in which the bolts have been spaced at the minimum distance allowable, and in which standard pressed-steel washers are used has also been prepared.

The modified fish-plate splice is easily framed, and for many joints is the most economical, when all factors are considered. All bolts are to have a driving fit in the timber. This is a condition that can easily be obtained with good inspection. The simplest method of assuring a driving fit with bolts is to examine the size of the bit which the carpenter uses, and to see that all holes are bored from one side only. In case a bolt has not a driving fit, it should be withdrawn, and another bolt of the next larger size be used. For this reason, it is well to detail such joints with a slightly larger spacing of bolts than is actually required.

Tabled Fish-Plate Type. The tabled fish-plate joint for the case under consideration is simple and effective. The stress of the chord and fish-plates is taken in tension, shear, and end-compression of the timber, with comparatively small secondary tension in the bolts. The bolts thus act in their most efficient manner, not being subjected to lateral forces. All cuts of the timber are square, and where the amount of the stress to be transferred across the joint in the chord can be taken by not more than two tables on either side of the chord joint, the detail may be regarded as reasonably certain in its action. Washers of generous size must be provided, in order that the joint may be well pulled together at the time of framing and the bolts be able to hold the tables in place when the stress comes into the splice. The calculations for Fig. 34 show a moment of 39,000 in-lb. to be counteracted by the tension of the bolts in each table, acting about the vertical cut in the chord, or the bearing end of each table. It is obvious that if the bolts

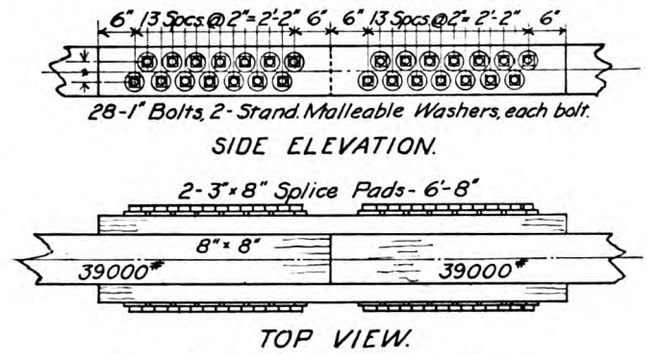
6" 13 Spcs. @ 2" = 2'-2" 6"
6" 13 Spcs. @ 2" = 2'-2" 6"
28-1" Bolts, 2-Strand. Malleable Washers, each bolt.
SIDE ELEVATION.
2-3" x 8" Splice Pads - 6'-8"
8" x 8"
39000#
39000#
TOP VIEW.

FIG. 33. MODIFIED FISH-PLATE SPLICE.

COMPUTATIONS

Bolts of 1 in. diameter will be used. The strength of one bolt in double shear with a thickness of fish-plate of 3 in. is, from Part III, 2664 lb.

Number of bolts required $= \frac{39000}{2664} = 14.6$. Use fourteen 1-in. bolts.

Distance required between bolts (total shearing area required, as before, 260 sq. in.):

	Inches
Spacing of bolts for shear $= \frac{260}{14 \times 6 \times 2} =$	1.55
Spacing required for transverse tension $= \frac{39000 \times 0.1}{150 \times 14 \times 6} =$	0.31
Adding diameter of bolts	1.00
Required spacing of bolts	2.86

Bolts will be spaced 2 in. staggered.

Required area of chord and plates for tension need not be investigated.

BILL OF MATERIAL FOR ONE SPLICE

	Pounds
Twenty-eight 1 by 16½-in. bolts at 4.81 lb	135.00
Fifty-six 1-in. standard malleable washers at 0.75 lb	42.00
Total weight of steel	177.00

Two 3 by 8-in. pieces 6 ft. 8 in. long = 28.00 ft. B.M. timber.

COST OF ONE SPLICE

Steel, 177 lb. at $0.04	$7.08
Timber, 28 ft. B.M. at $0.04	1.12
	$8.20

For a rigid comparison with the previous type, the spacing of the bolts would be decreased to 3 in., and circular steel pressed washers used. The bill of material and cost would then be as follows:

BILL OF MATERIAL

	Pounds
Twenty-eight 1 by 15½ in. at 4.60 lb	128.6
Fifty-six 1-in. circular washers at 0.16 lb	9.1
Two 3 by 8-in. pieces 5 ft. 3 in. long = 21.0 ft. B.M.	137.7

COST OF ONE SPLICE

137.7 lb. steel at $0.04	$5.55
21 ft. B.M. timber at $0.04	0.84
	$6.39

ence might be drawn that the design was the most economical that could be made. Such an inference would be correct, were the price of metal the same for all sizes of bolts, or for stock bolts or lateral pins. The criticism that I make of the design under discussion is that bolts of a smaller diameter are not given credit for the resistance that they can develop. A joint framed with the bolts nearly two inches in diameter has the appearance of a monstrosity when actually viewed in the field, and always excites the ridicule of the carpenter. It is granted that the carpenter's opinion has no bearing on the case, if the design is correct. However, the carpenter in this instance knows what is undoubtedly true, that the designer did not realize that bolts of a smaller diameter are capable of developing much more resistance to lateral shear than is stated in the textbooks.

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should fail to hold the fish-plates in place, this moment would have to be taken by the plates acting as beams in flexure. The net section modulus of the plate at the plane of the cut for the table is $\frac{1}{6} \times 8$ in. $\times (2\frac{1}{2}$ in.$)^2 =$ 8.35. The flexural stress would therefore be $\frac{39{,}000 \text{ in.}}{8.35} =$ 4680 lb. per sq. in., and the maximum stress on the fish-plate would be 4680 lb. $+ \frac{19{,}500 \text{ lb.}}{2\frac{1}{2} \times 8} = 5655$ lb. per sq. in., a value far beyond the allowable safe stress. The joint is therefore dependent to a large degree on the tightness with which the timbers are held in place by the bolts, and excessive shrinkage in the timber would allow the fish-plates to be overstrained. In such a joint, if thoroughly seasoned timber is not certain to be employed, the fish-plates should be given a generous section, and additional bolts over those required by the computations should be provided. Spiking in the form of toe-nailing will also assist in holding the fish-plates in place. The bolts resisting the tension due to the incipient bending should be placed at the centre of the tables, in order that the fibres of the fish-plates will receive equal bearing under the washers.

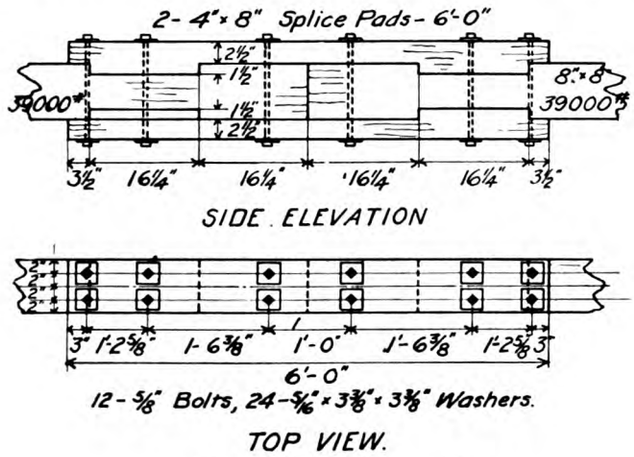

FIG. 34. TABLED FISH-PLATE SPLICE.

COMPUTATIONS

Depth of cut for table and chord: Area required for cut $= \frac{39000}{1600 \times 2 \times 8} = 1.52$ in. Make $1\frac{1}{2}$ in.

Length of table for shear: Area required $= \frac{39000}{8 \times 2 \times 150} =$ 16.25 in. Make $16\frac{1}{4}$ in.

Size of bolts required: The resultant stress in the fish-plate acts at the centre line of the uncut portion, while the resultant of the pressure of the table on the chord acts at half the depth of the cut. The total thickness of fish-plate should be 4 in., since a 3-in. piece of timber would not give sufficient area for tension. There is thus a couple acting on the fish-plate equal to one-half the stress in the chord multiplied by one-half the thickness of the fish-plate, or 19500 lb. $\times$ 2 in. $=$ 39,000 in.-lb. This moment must be resisted by tension in the bolts acting about the bearing face of the tables. The bolts should be placed at the centre of the tables. Their lever arm is therefore 8 in., and their stress $\frac{39000}{8} = 4875$ lb. Two $\frac{5}{8}$-in. bolts will be provided. In addition, for binding the joint together, eight $\frac{5}{8}$-in. bolts will be placed as shown in the detail.

BILL OF MATERIAL FOR ONE SPLICE

	Pounds
Twelve $\frac{5}{8}$ by $14\frac{1}{2}$-in. bolts at 1.50 lb.	18.00
Twenty-four washers $\frac{5}{16}$ by $3\frac{3}{8}$ by $3\frac{3}{8}$ in. at 1.02	24.50
Total weight of steel	42.50

Two 4 by 8-in. pieces 6 ft. long = 32.00 ft. B.M. timber.

COST OF ONE SPLICE

Steel, 42.50 lb. at $0.04	$1.70
Timber, 32 ft. B.M. at $0.04	1.28
	$2.98

Steel-Tabled Fish-Plate Type. The calculations necessary in the design of this type of splice are similar to those of the Type C end joint. The net area of steel in the plates, the bearing area of tables, number of rivets in the tables, their spacing for longitudinal shear on the timber, the number of bolts to hold the tables in position, and the net area of timber must all be sufficient to hold their respective stresses.

The splice is an effective one, and is fairly economical where good work in the fabrication of the metal can be obtained. The detail works well for joints carrying

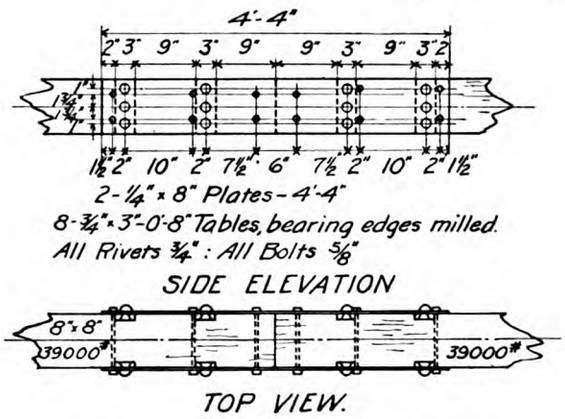

FIG. 35. STEEL-TABLED FISH-PLATE SPLICE.

COMPUTATIONS

Bearing area required for tables $= \frac{39000}{1600} = 24.4$ sq. in.

Total combined depth of tables $= \frac{24.4}{2 \times 8} = 1.53$ in. Make $1\frac{1}{2}$ in.

Will use tables $\frac{3}{4}$ by 8 in., requiring eight tables in all.

Each table transmits $\frac{39000}{4} = 9750$ lb., and requires three $\frac{3}{4}$-in. rivets, as determined by bearing on a $\frac{1}{4}$-in. plate.

Net section of $\frac{1}{4}$ by 8-in. steel plate $= \frac{1}{4} \times [8 \text{ in.} - (3 \times \frac{7}{8} \text{ in.})]$ $= 1.34$ sq. in.

Net section of one plate required $= \frac{39000}{2 \times 16000} = 1.22$ sq. in.

Size of bolts required to resist moment on tables: Moment $= 9750$ lb. $\times \frac{1}{2}$ in. $= 4857$ in.-lb. Tension in bolts $= \frac{4875}{3\frac{1}{2}} =$ 1400 lb. Will use two $\frac{5}{8}$-in. bolts.

BILL OF MATERIALS FOR ONE SPLICE

	Pounds
Two $\frac{1}{4}$ by 8 by 4 ft. 4 in. plates at 29.4 ft.	58.8
Eight $\frac{3}{4}$ by 3 by 8-in. tables at 5.1 lb.	40.7
Twenty-four $\frac{3}{4}$-in. rivet-heads at 0.14	3.4
Twelve $\frac{5}{8}$ by $9\frac{1}{4}$-in. bolts at 1.14	13.7
Total weight of steel	116.6

COST OF ONE SPLICE

Steel, 116.6 lb. at $0.04	$4.67

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heavy stresses. The objections that may be offered to the splice, outside those of cost of materials, are the number of tables that may be required, necessitating careful fitting into the timber, in order that snug and uniform bearing may be assured between steel and timber. For this reason the detail may be listed in the class that especially requires good and careful inspection on the part of the engineer.

Tenon-Bar Type. The bar and tenon splice is one of the older types of timber splices, and was formerly used to considerable extent in bridge work, but is not often seen at the present time. It is distinguished from all other splices by its simplicity and directness. There is but one bearing surface, consequently the area taken out by the bar is a large part of the gross area of the chord. As the bar is rectangular in shape, the full end-bearing value of the timber can be taken advantage of, and there is no cross-tension on the timber tending to split the chord. The detail computations consider the size of bar for bearing against the ends of the fibres, and for bending in the bar, the required distance between the bar and the end of the timber for shear, the net section of chord, and the area of tension bolts, using, of course, the area at the root of threads. It should be observed that the length of the bar is determined by the long diameter of the hexagonal nut of the bolts, so that sufficient distance may be obtained for tightening the nuts. As the bar is a short beam in bending, the high unit flexural-stress of 24,000 lb. per sq. in. is permissible. For holding the splice firmly together, two 2 by 8-in. pads have been provided, bolted through the chord. This will be necessary wherever a single stick is to be spliced. In the case of a built-up chord, such as is usual with a railroad or highway bridge of long span, the entire chord is never spliced at one point, the splices in the individual timbers of the chord being staggered. Packing blocks are provided between the sticks, through-bolts being used to bind the whole together thoroughly.

Shear-Pin Type. In this detail, the tension is transmitted by shear in the pipe or hardwood pins, and a consequent secondary tension in the bolts. The working values are in accordance with the results of tests, as described in Part II of this series of articles. With thoroughly seasoned timber, the detail is a reliable one. It should be remembered that this detail should not be employed with very green timber, as the ability of the pins to transmit shear is a function not alone of the end-bearing value of the timber, but also of its strength in cross bearing. In the action of the splice, there is a couple on the pin, tending to spring it out of its hole. Any shrinkage in the timber will allow some slip of the joint, because of the action described.

General Summary of Tension Splices. As was stated in the case of the estimates of costs of the different types of end joints, the figures representing the costs can be regarded as only approximate. The actual amount of labor required for each type of detail, whether end joint or tension splice, is difficult to estimate accurately. In the costs given herein, all timber in place has been

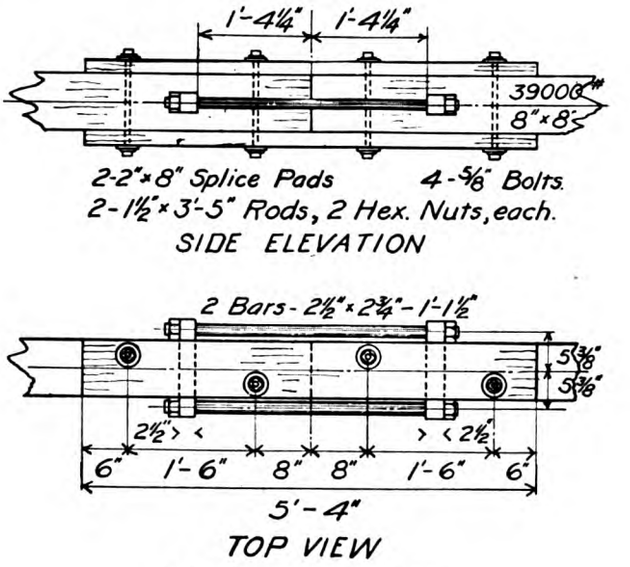

FIG. 36. TENON-BAR SPLICE.

COMPUTATIONS

Size of rod: area required $= \frac{19{,}500 \text{ lb.}}{16{,}000} = 1.22$ sq. in.

A 1½-in. rod has an area at root of thread of 1.295 sq. in. Use this size.

The long diameter of a 1½-in. hexagonal nut is 2¾ in., hence the distance from the side of the timber to the centre line of the bolt must be slighty more than 1⅜ in. Will make this distance $1\frac{7}{16}$ in.

Size of bar required: The bearing of the timber against the bar will be assumed to be uniform per unit area of bearing. Hence the bending moment on the bar will be 19,500 lb. × [$1\frac{7}{16}$ in. + (¼ × 8 in.)] = 19,500 lb. × 3.4375 in. = 67,000 in.-lb.

The required bearing area is $\frac{39{,}000 \text{ lb.}}{1{,}600} = 24.4$ sq. in.

The required width of bar is therefore $\frac{24.4}{8} = 3.07$ in. Use 3 in.

Use a fiber stress of 24,000 lb. per sq. in., since the case is that of a short beam restrained at the ends to some extent.

The necessary section modulus is $\frac{67000}{24000} = 2.79$ in.

$\frac{bh^2}{6} = 2.79 = \frac{3 \times h^2}{6}$. Therefore $h = 2.37$ in.

Will use bar 2⅜ by 3 in.

The shearing length required, or the distance between the edge of bar and the end of the timber, is $\frac{39000}{150 \times 2 \times 8} = 16.23$ in. To this distance will be added one-half the width of the bar, making the distance from the centre of bar to the centre of splice, say, 1 ft. 5½ in.

BILL OF MATERIAL FOR ONE SPLICE

	Pounds
Two steel bars, 2⅜ by 3 in. by 1 ft. 5⅝ in. at 35.6 lb	71.2
Two 1½-in. rods, 3 ft. 4½ in. long at 20.2 lb	40.4
Four hexagonal nuts at 2.0 lb	8.0
Four ⅝ by 13½ in. at 1.4 lb	5.6
Eight ⅝-in. standard malleable washers at 0.23 lb	1.8
Total weight of steel	127.0

Two 2 by 8-in. pieces 5 ft. 6 in. long = 15 ft. B.M. timber.

COST OF ONE SPLICE

Steel, 127 lb at $0.04	$5.08
Timber, 15 ft. B.M. at $0.04	0.60
	$5.68

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figured at the same rate, and the same statement applies to the steel, whether such steel is forged, riveted, or is in the form of bolts. This assumption would be justified only in the case of a very large job. On a small job comprising only a few roof trusses, this method of estimating costs would probably be seriously in error. Again, prices of material fluctuate, not alone in relation to time, but also with the situation of the job. It will be recognized, therefore, that not alone must the prices of the different types of tension splices be taken as only approximate, but that their relative costs must be regarded as only comparatively accurate.

While the relative cost of any one type of tension splice is a vital factor to be considered, other considerations than cost alone will generally decide the detail to be used. For example, where the roof truss is to be exposed, wooden splice-pads may be objectionable from the standpoint of appearance. In such a case, steel plates are a necessity, unless a laminated chord be used, and the problem will then resolve itself into a question of using a bolted-steel fish-plate splice, or a tabled-steel fish-plate.

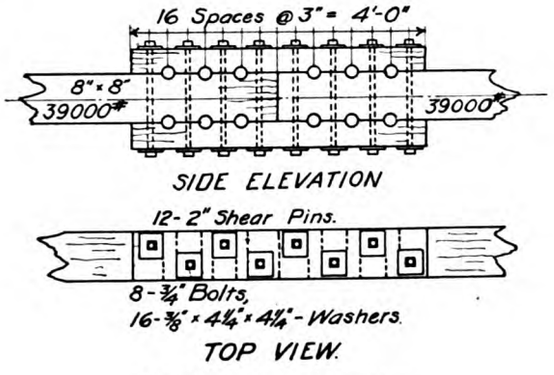

FIG. 37. SHEAR-PIN SPLICE.

COMPUTATIONS

Using fish-plates of 3 by 8-in. timbers, the net section of plates will be 4 by 8 in. = 32 sq. in. The unit tensile stress in the plates will then be $\frac{39000}{32} = 1216$ lb. per sq. in.

The number of 2-in. pins required will be $\frac{39000}{8 \times 800} = 6.1$. Use six pins.

The tension to be taken in the bolts will be 19,500 lb., requiring $\frac{19500}{4830} = 4.03$ or four ¾-in. bolts.

For developing the bolts, plate washers, ⅜ by 4¼ by 4¼ in. will be used.

BILL OF MATERIAL FOR ONE SPLICE

	Pounds
Eight ¾ by 15½-in. bolts, at 2.32 lb	18.56
Sixteen washers, ⅜ by 4¼ by 4¼ in., at 1.92 lb	30.70
Total weight of steel	49.26

Twelve 2-in. pipe-pins or hardwood pins.
Two 3 by 8-in. pieces 4 ft. long = 16 ft. B.M. timber.

COST OF ONE SPLICE

Steel, 49.3 lb. at $0.04	$1.97
Twelve pipe-pins at $0.10	1.20
Timber, 16 ft. B.M. at $0.04	0.64
	$3.81

In the case of joints in which the stresses to be resisted are comparatively small, the modified bolted fish-plate splice will be found satisfactory. In the case of the truss illustrated here, the number of bolts required is too large from a practical standpoint, and the tabled fish-plate detail is, perhaps, the most satisfactory of the types shown. Where the stresses are still larger, the tabled-steel fish-plate will be found to offer an economical solution. Of the various types of splices illustrated, the bar-tenon type is the only one that is practically free from the effects of shrinkage of the timber. Next may be classed the bolted fish-plate, followed by the steel-tabled fish-plate, the wooden-tabled fish-plate, and lastly, the shear-pin splice.

Shrinkage is a factor that is almost impossible to avoid. For this reason, in all timber design, it is well to use conservative stresses. In the case of a roof truss, there usually exists a considerable safety factor in the live load assumed in the design. Where the timber work is protected from the weather, and at the same time is accessible for inspection, the joints should be carefully watched, and the bolts tightened as the timber shrinks. If the structure is a building that is heated, the full shrinkage may occur in a few weeks. Green timber may take one or two years to season completely. It should be emphasized, therefore, that thoroughly seasoned lumber only should be used for construction which will not be accessible for inspection and maintenance.

In addition to the requirements of computed stresses in tension splices, the unknown stresses of erection must be provided for. A splice joint should always, therefore, have some general stiffness in addition to its capacity to resist the known stresses. An illustration of this statement is seen in the detail of the bar-tenon type, in which two 2 by 8 in. splice-pads are used, although not required theoretically. The general statement may be made that, where it is possible to secure chords of full length so that splicing may be eliminated, it is better to use the long sticks, even at a considerable increase in the unit cost of the timber.

Compression Splices

Compression splices may be divided into two classes, those which take compression only, and those which may be called upon at some time to take either flexure or tension, or a combination of each.

As in the case of tension splices, it is not the purpose to discuss here the many types of joints which are employed in timber construction. Each type has its advantages and disadvantages. The reader who is interested in the subject will find a very complete description and discussion of timber joints in Chapter II of Jacoby's 'Structural Details.' Three of the most common types of compression splices are shown in Fig. 38. These may be termed the butt joint, the half lap, and the oblique scarf, respectively. The figure illustrates the fundamental difference between the butt type and all others, namely, that the former has only one surface of contact, and the others two. In accordance with the principle

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already mentioned, that all timber joints should be made as simple of fabrication as possible, the butt joint is superior to the others, whose efficiency is largely dependent upon the experience and the care of the carpenter in framing. It is self evident that one bearing surface is always better than two.

In the butt joint shown, the thickness of the splice-pads and the number and size of the bolts may be varied to accommodate the conditions existent in the member, whether the splice-pads are required only to hold the main timbers firmly in position, or must transmit tension or compression across the joint. In cases where the main member must resist considerable flexure, it may be necessary to use metal or hardwood shear pins in addition to the bolts.

The oblique scarf has more flexural strength than the half-lap; otherwise I consider it much inferior to the half-lap. There is much less timber in straight end-bearing in the oblique scarf than in the half-lap, and the

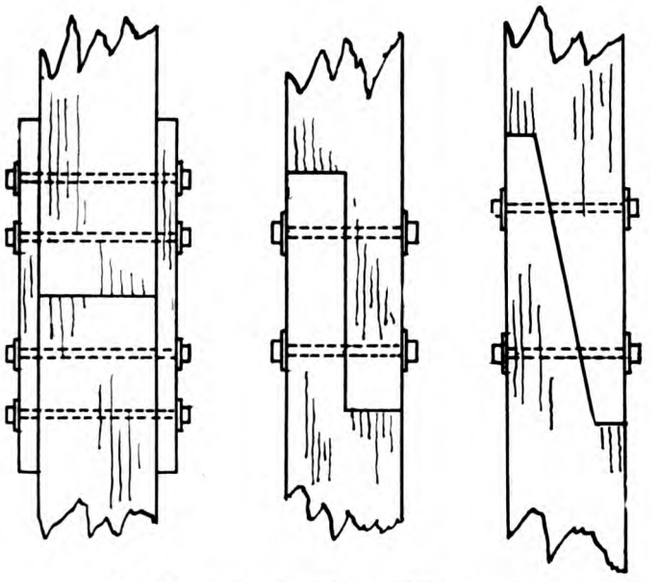

FIG. 38. TYPES OF COMPRESSION SPLICES.

oblique cut, if unresisted by the normal cuts would tend to separate the two timbers.

In erecting a structure, in which the member to be spliced is vertical in position, the bolts through one end of the splice pads should be placed in the field, so that the joint may come to a full bearing before the bolt holes are bored.

Fig. 39 and 40 show two details of the upper-chord joint of a small timber highway bridge, in which the batter-post frames into the upper chord. Here again the comparison may be made between a somewhat complicated detail, as illustrated by Fig. 39, and a joint in which but one straight cut is required, as in Fig. 40. The latter detail fulfills all the functions of the former, and there seems to be no need for the double cut of the first detail. If any further fastening between the chord and batter post is required than is given by the detail of Fig. 40, it is best obtained by splice pads across the joint, either of steel or timber.

General

All of the joints of the present and previous articles are of the class that may be termed the open type, as opposed to the closed, or housed class, the latter embracing the simple housed, the cogged, the halved, the dovetailed and other joints. The housed joints, with the exception of the halved joints, are seldom seen in building construction. The housed joints are used in mine timbering, both above and underground, and also in crib-

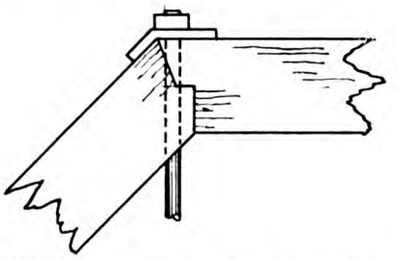

FIG. 39. COMPLICATED UPPER-CHORD DETAIL.

bing. Aside from the fact that they are more difficult to construct, they offer more chance for decay than the simple open joints, and their efficiency is but a small proportion of the total strength of the timber. For example, the main timber is badly cut by an entrant tenon, compression across the fibres is introduced, and the effect of cross shrinkage of the timber is a maximum. The

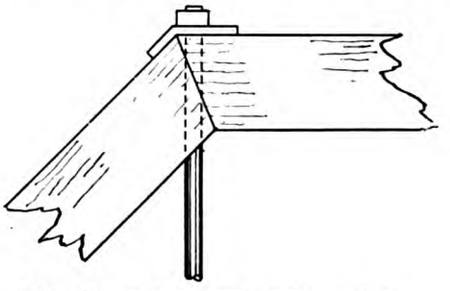

FIG. 40. SIMPLE UPPER-CHORD DETAIL.

use of such joints requires large timbers working at a low unit-stress, or, in other words, at a low efficiency. In a subsequent article typical details of miscellaneous timber structures, other than buildings, will be discussed, including the efficiency of the various joints, applying the principles that have been presented in this and the preceding articles.

A scheme of primary triangulation is being carried from Dixon Entrance to the southern point of Vancouver Island. It is expected that the Geodetic Survey of Canada will also extend a primary triangulation from White Pass, at the head of Lynn canal, down the Yukon river to connect with the triangulation along the one hundred and forty-first meridian. When work now planned is completed there will be a connected primary triangulation from latitude 59°, through Alaska, Canada, the United States, and Mexico to latitude 16°, a difference of 43° in latitude. It will be a great advantage to both Canada and Alaska to have this new primary control.

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Standard Nomenclature for Street Improvements

The following standard units are recommended by A. Prescott Folwell, chairman of the Committee on Standard Forms of the American Society of Municipal Improvements. Their general adoption by city officials throughout the country will make possible a rational comparison of cost data.

Pavement: The wearing surface down to the base, if any. Includes cushion or binder course, but not concrete, macadam, or other base. If base is included, describe as "pavement and .... inch ..... base." In the case of macadam or concrete pavement, the term includes all down to the earth foundation. Unit, the square yard, giving material and thickness. Example, 1524 sq. yd. of 3-in. asphalt pavement.

Base: The concrete, macadam, or other material placed under the pavement to distribute the load on the subgrade. Unit, the square yard, naming thickness and material. Example, 1524 sq. yd. of 6-in. concrete base.

Excavation, embankment: All material removed before laying base, curb, or sidewalk; or all material added, up to base, curb, or sidewalk. Unit, the cubic yard, naming material. Example, 600 cu. yd. of earth excavation.

Curb: Complete construction of new curb, except excavation or embankment. Resetting curb: Same, except for furnishing of curb stone. Unit, lineal foot, stating (in inches) depth and mean width of curb, and material. Example, 952 ft. of 7 by 18-in. granite curb reset; 750 ft. of 6 by 16-in. concrete curb.

Gutter: Same as curb. Unit, the square foot, stating thickness and material. Example, 1428 sq. ft. of 6-in. concrete gutter.

Sidewalk: The artificial wearing surface, not including excavation or embankment, nor base of cinders or other material, if any. Unit, the square foot (or square yard, if preferred), giving average thickness and material. Example, 1720 sq. ft. of 6-in. concrete sidewalk.

Sidewalk base: Cinders or other material placed under sidewalk. Unit, the cubic yard, naming material. Example, 122 cu. yd. of gravel sidewalk base.

Construction sewer: Excavating trench (except rock and street pavement), furnishing material for and constructing or laying the sewer barrel (not including branches, manholes or other appurtenances, special foundations, etc.), and backfilling (not including relaying pavement). Excavation of rock, sheathing left in trench, and removal and replacing of pavement paid for extra. Depth of excavation is measured from street surface to invert of sewer, and classified by two-foot intervals. Unit, the lineal foot (measured along the entire length of the sewer, including manholes and specials), naming size of bore and material of sewer, and depth. Example, 10-in. vitrified sewer, 950 ft., 8 to 10 ft. deep; 630 ft., 10 to 12 ft. deep.

Branches: Y or T branches inserted in the sewer; the price paid to be additional to that paid for the sewer in which the branch is inserted.

Manhole: The total structure, including bottom and top casting, steps, etc., additional excavation and backfilling. Standard to be taken as 6 ft. deep, and depths exceeding this to be given in additional feet depth. Price is in addition to that paid for sewer (measurement for which includes manholes, as stated above). Unit, manhole of standard depth, giving bottom diameters in feet; and feet of additional depth. Example, 7 manholes 3 by 4½ ft. and 22 ft. additional depth. (This means that the sum of the depths was 64 ft. and the average depth was 9 1/7 ft.)

Replacing pavement: Grading top of trench backfill, putting in pavement foundation (if any), and laying wearing surface (replacing any material damaged in removing same. Unit, the square yard, naming kind of pavement. Example, removing and replacing 726 sq. yd. of brick pavement.

STATISTICS OF PETROLEUM REFINERIES

An article recently published in the *Oil City Derrick* gives the following table of data regarding refineries:

PETROLEUM REFINERIES IN THE UNITED STATES:

State	No. of refineries	Barrels crude estimated	Investment estimated
California	76	211,300	$81,000,000
Utah	1	500	35,000
Colorado	3	5,000	825,000
Wyoming	4	34,000	18,561,000
New Mexico	1	150	15,000
Kansas	21	34,250	8,252,000
Oklahoma	41	105,075	17,500,600
Missouri	3	13,000	3,136,000
Texas	23	179,800	47,350,000
Louisiana	16	42,150	7,750,000
Illinois	11	39,650	8,600,000
Indiana	1	60,000	25,400,000
Ohio	10	30,900	6,600,000
Pennsylvania	56	109,470	40,000,000
New York	11	42,000	50,000,000
New Jersey	10	111,000	105,600,000
West Virginia	6	4,500	2,250,000
Maryland	5	20,500	5,250,000
Kentucky	2	.....	.....
Tennessee	1	.....	.....
Total	302	1,043,245	$428,124,600
Idle	26		
Building	11–37		
Total active	265		

Nineteen of the refineries in California are not operating at the present time. When refineries now under construction in Oklahoma are completed, the total capacity of those in the State will be 145,000 barrels per day. The daily production of crude oil was about 850,000 barrels in 1915, or not enough to keep all the refineries busy.

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The Motor-Truck in Arizona*

By WILBERT G. McBRIDE

Two Alco 3½-ton motor-trucks were used by Young Bros. while operating at the Mammoth Collins mine at Shultz, Arizona. One was equipped with an oil-tank holding 1075 gal. and was used for the transportation of 'tops.' The other was fitted with a stake body and used to carry machinery, wood, rails, pipe, and all classes of miscellaneous supplies. The bodies were made of oak with maple flooring and were attached to the frame of the chassis by U-bolts, to avoid drilling the main members of the frame.

Most of the hauling was done from Tucson, a distance of 47½ miles. During the first three months, part of the road was in bad condition and the tire cost was excessive. After this part was repaired, the road was in fair condition, but never good. There were no excessive grades or bad sand, but wagon-ruts, too narrow for the truck-wheels and of a different gage, caused heavy tire loss; while chuck-holes, sharp curves, and stones, both imbedded and loose, were objectionable features. During wet weather the trucks could not get sufficient traction to climb some of the hills and were likely to stick in the mud, so that no attempt was made to run them unless they were on the road when the rain started. This lost time amounted to about 5% of the total, but, whenever possible, it was utilized in making minor repairs.

The price of gasoline was from 17 to 21c. per gal. Rubber tires were used throughout. Drivers were paid $4.50 to $5 per shift, and a return trip to Tucson was counted as two shifts even when made in one day. Drivers were provided with a room in Tucson and were paid for all time lost due to causes beyond their control. Trucks were loaded one way only.

Speedometers were placed on both trucks, but the excessive vibration soon caused them to fail. For this reason, and because no account was taken of the distance covered in picking up a miscellaneous load or in other minor ways, the mileage given is under the actual distance traveled. Some of the weights had to be estimated, but care was taken to have the number of ton-miles low rather than high, to avoid under-estimating the costs. The cost of hauling from Tucson to the mines was $12 per ton with the trucks, while the best possible team price was $15. Teams made one return trip a week, while the truck regularly made one in two days and could always, and many times did, do it in one day. The loss of time due to wet weather would be about half as much with teams as with trucks.

The table of detailed costs given below covered the period from August 21, 1913, to August 15, 1914, the only time in which the trucks were continuously employed. From August 15, 1914, to March 30, 1916, the trucks were used intermittently, but the figures for this period have been excluded as not being representative. If included, they would lower the cost per ton-mile. Just prior to the close of the period covered by the figures, the trucks were overhauled and put in good condition; new rear-wheels were put on and new tires substituted. The cost of all this was charged to operation. Allowances for extra tires on hand would reduce the cost per ton-mile approximately ¾c., leaving a net cost of about 25c. With loads on the return-trip this cost per ton-mile would be lowered at least 40%.

OPERATING DATA

Total distance traveled by trucks	23,000 miles
Total work done by trucks	42,700 ton-miles
Average distance covered per gallon of gasoline	4.5 miles
Average distance covered per gallon of lubricating oil	128 miles
Average speed, loaded	7 miles per hour
Average speed, light	7.8 miles per hour

DETAILS OF COST

	Total cost	Per cent of total	Per truck-mile	Per ton-mile
Wages of drivers	$2,623.32	23.91	$0.1141	$0.0614
Wages of helpers	286.50	2.62	0.0125	0.0067
Repairs, labor	581.74	5.30	0.0253	0.0136
Repairs, lost time	156.15	1.42	0.0068	0.0037
Oils, grease, and waste	379.17	3.46	0.0165	0.0089
Gasoline	1,610.49	14.68	0.0700	0.0377
Tires	2,445.75	22.30	0.1063	0.0573
New parts	515.08	4.69	0.0224	0.0121
Miscellaneous supplies	348.82	3.18	0.0152	0.0082
Incidental expense	226.21	2.06	0.0098	0.0053
Depreciation	1,796.80	16.38	0.0781	0.0421
Total	$10,970.03	100.00	$0.4770	$0.2570

The advantage of the motor-truck over the team and wagon are many—increased speed, ability to work 24 hours per day when necessary, and lower cost on long hauls—but its adoption by the mining industry has been slow. Where trucks are used around mines they are usually driven by cheap inexperienced men, the upkeep and repairs being turned over to the regular mine mechanics. It would be equally good practice to employ a timber-framer to make a dining-room table. Just as the niceties of cabinet-making are unknown to the timber-framer, the ex ct adjustments and fine workmanship of the high-speed engine and transmission-gears of a motor-truck are beyond the ken of the mine mechanic, one of the least skilled of his class. If there are enough motor-vehicles at the mine, the master mechanic probably turns the work over to one or two men who, in time, become in-

*A paper read before the Arizona (September 1916) meeting of the American Institute of Mining Engineers.

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different auto-mechanics, but in the meantime the cost of maintenance soars and often the trucks are condemned. The aim of the makers of all motor-vehicles is to secure the maximum of strength and power with a minimum of weight and size. To do this, high-speed engines, the best of materials, and the finest of workmanship are employed, and parts are reduced to the least possible weight consistent with strength and durability. This is just the reverse of the ordinary American mechanical practice, in which reliability is secured by slow speed and large size, the amount of material used and the space occupied being minor considerations. It is, therefore, unreasonable to expect the mechanic trained in one school to understand immediately and adapt himself to the ways of the other. It must also be remembered that no other machine is given the hard use and necessary abuse that motor-trucks receive. The vibration while on the road will loosen nuts and rivets, and this, if not attended to in time, will cause serious trouble. Where only one or two trucks are used, the drivers should be competent mechanics and should be held responsible for the maintenance of their machines. Where several are used, they should be under the direct supervision of a thorough truck-mechanic that is held responsible for operation and given entire control of the drivers and repair-work. His constant care will detect and remedy many incipient defects and prevent expensive and annoying break-downs. With the exception of the time required for periodic overhauling, he should be able to keep the trucks in almost continuous service. This will make possible the employment of cheaper drivers without undue damage to the machines.

Motor-trucks should not be installed without careful consideration of the roads to be traveled. The difference between the cost of motor-truck and team-hauling is largely controlled by the quality of the road, and on really bad roads the motor-truck is decidedly the more expensive. Many roads are fatal to truck-haulage, and considerable experience is required to decide this question without an actual test of some duration. Excessive grades are to be avoided, especially long ones. The ordinary truck will pull over a short 20% grade with ease, but will give great trouble on a long one of half that rise unless special cooling arrangements are made. Grades greatly increase the tire and gasoline consumption and decrease the life of the machine. Rocky roads, particularly when the rocks are sharp or loose, are hard on tires. Deep sand is difficult to cross, and for this class of road the caterpillar tractor and the four-wheel-drive truck have distinct advantages. Trucks that drive on the rear wheels only cannot operate in heavy sand. Narrow or rutted roads are objectionable for the larger-sized trucks because they throw all the weight on one of the rear dual-tires from time to time, and this over-loading is injurious to the rubber. Fairly deep streams can be crossed, but mud is an absolute barrier except to the caterpillar type of tractor. Few dirt-roads will stand up under a 7-ton truck, but those of 4 tons, or under, do less damage than the ordinary freight-wagon.

Unfortunately, trucks are not designed to suit mining conditions. At Shultz we found it necesary to cut down the gear ratio, increase the size of the wheels and tires, and add bumper or auxiliary springs. Had the grades been steeper it would have been necessary to increase the cooling capacity.

For long hauls the motor-tractor will probably replace the motor-truck. It will operate at a lower cost because the load will be carried on iron tires, and, as the table of detailed cost shows, the rubber tires account for 22.3% of the total. Tractors travel more slowly than motor-trucks, but the tonnage hauled on a trip is much greater. They are also easier on roads, as the load is distributed over several trailers. By using extra trailers, loading and unloading can be done on the road.

The make of a truck is not as important as the care it receives. Almost any standard make will do good work if given careful attention, but none will be satisfactory if not well cared for. Economy should not be sought in the lubricants used; the best oil is none too good. Overloading should be scrupulously avoided. A truck may be made to carry many times its rated load without breaking down, but the damage is none the less real because not immediately apparent. High speed, particularly if the road is rough, should be avoided, since it subjects the machine to excessive strain and vibration. Most trucks are now equipped with speed-governors, but these are easily tampered with and must be carefully watched. When they are not used, the drivers should be carefully instructed as to the speed-limits and compelled to respect them.

Distillate and 'tops' are now successfully used on trucks, by the application of a special carbureter. The use of these should effect a material saving in the gasoline cost, which now amounts to almost 15% of the total. 'Tops' usually sells for 30 to 35% and distillate for 50 to 60% of the price of gasoline. With a properly designed carbureter, the available power in the lower-grade fuel will be about the same as in the gasoline, but the carbon deposition will probably be somewhat greater.

'The International System of Electric and Magnetic Units' is the subject of Scientific Paper No. 292, which has just been published by the United States Bureau of Standards. The paper gives full descriptions of the existing methods of measurement and those which have been proposed, and states the advantages of the methods already approved. All electrical measurements in the various countries are based on certain standards. These standards represent the units, such as the volt and ampere, in terms of which measurements are expressed. Several different systems of electric and magnetic units have been proposed from time to time. These systems have been put forward as having noteworthy advantages in a theoretical way over the units which are ordinarily used. A careful study, however, has shown that the advantages of the proposed systems are not such as to justify a general change of units. In fact, the paper shows that the ordinary units are superior.

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Estimating the Cost of Highway Construction

The following report was made to the Second National Conference on Concrete Road Building, which was held at Chicago, in February 1916, by a committee composed of A. Marston, chairman, dean of the division of engineering, Iowa State College, John H. Mullen, deputy state engineer for the Minnesota State Highway Commission, K. H. Talbot, division engineer for the Universal Portland Cement Co., and H. A. Johnson, a contractor of Kalamazoo, Michigan. While the report was prepared primarily with reference to concrete roads, a large part of the suggestions contained therein are applicable to other forms of highway construction.

Estimating Problems

The science of computing the probable cost of any piece of road construction is, at best, not an exact one, and judgment, based on experience on other work and on a consideration of local conditions, must determine largely the basis on which such an estimate is made. A careful personal inspection of the road should be made in every case before trying to arrive at any conclusions regarding the actual cost of the work. Experience goes to show that there has been in the past a certain class of contractors who have examined the estimate of the engineers, then have bid as much below the estimate as they thought necessary in order to secure the contract. They made no analysis of cost. This class of bidders is now coming to realize that, with keener competition, and the larger mileage which is being put under contract in each job, a detailed analysis of cost is a prerequisite to bidding. Some estimators make a practice of driving over the road in question; but the more careful walk over it, noting the various physical characteristics that will in any way affect the cost of the construction. An examination may reveal a wet spot here, a spring there, a good place for an unloader, a site for a sidetrack, the position of a creek or water hole in which a pump can be installed, and such other peculiarities of the particular job as may affect the ultimate cost materially. In an investigation of this nature there are a number of elements which affect the cost, and also the speed with which the work can be accomplished. To discuss all of these at length, would require much more time than is at our disposal. A few of the more important may, however, be mentioned.

Cost of Provision for Traffic During Construction

Effect of Character and Extent of Traffic: The provision necessary for caring for traffic during construction is dependent upon the nature and the amount of such traffic. For roads in a farming community the maximum traffic usually occurs during the time when the crops are being hauled to market, and can be served perhaps by a temporary roadway alongside of the new road-bed or through adjacent fields. Under other conditions many factors tend to complicate this problem. For example, on a road adjacent to a fair-ground, considerable expense will probably be entailed in making adequate provision for traffic such as will occur when the fair is in progress. A detour through adjacent fields which would be adequate for ordinary hauling will prove entirely inadequate for heavy motor traffic. Every main highway or tourist road constitutes a special problem, and a traffic provision suited to local needs must be provided in each case. For these reasons traffic conditions must be taken into account in preparing an estimate.

Effect of Season of Year: The season of the year during which the road is to be constructed will also affect the cost of caring for traffic. The construction of a road that will be only partly completed late in the fall will entail the additional expense of placing the road in condition so that winter hauling can be carried on at minimum inconvenience, and also with minimum harm to the unfinished roadway. Obviously, the weather conditions during the time when traffic must be provided for will greatly affect the cost of that item. These and many other conditions emphasize the fact that an accurate estimate of this item of the cost can be made only when the approximate time of year during which the construction will be carried on is known beforehand. The time set for beginning the work and the estimated rate of progress will indicate the period during which construction will be under way.

Local weather conditions and the character of the subsoil have much to do with the possible date of starting construction. From residents along the right-of-way information concerning the state of the road in spring and early summer can be obtained, from which may be determined, with reasonable accuracy, the probable date upon which it will be practicable to start construction. The character of the topography and of the vegetation on adjacent land sometimes influences to a considerable extent the rapidity with which a road will dry in the spring. For example, a roadway passing through a dense forest growth will probably be wet and muddy at a much later date than one which is so situated as to get the full benefit of the sunshine. It may be necessary to resort to dragging and draining a part or all of the road to be improved, in order to place it in condition to commence construction work. The cost of dragging and surface draining will usually vary from $5 to $10 per mile, but may amount to much more. Small items of cost such as these may seem trivial in comparison with the cost of the finished work, but collectively they may represent the difference between profit and loss.

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Effect of Detour Routes Available: The routes for detouring traffic during construction also vary with the locality, and may modify the cost of construction to a considerable extent. In prairie States, the highways, in general, follow section lines and the maximum detour will not be more than two or three miles, but in a hilly country, where a road is in a valley or on the side of a hill, the problem is not so simple. Here it may be the part of economy to change the detail or section of the road considerably, placing the concrete road against the upper slope with a gutter along the edge, and putting the full width of shoulder along the lower side, this wide shoulder serving also as an earth track during construction. A change in detail of this kind must be taken into account and provided for before construction commences.

Cost of Hauling Materials

Effect on Cost of the Character of Railway Terminal Facilities: An important item in the expense of hauling materials is the cost of unloading at the railway terminal. In estimating the probable cost of this item, there are several factors which must be taken into consideration. The character of the terminal facilities will affect the cost. Delays due to the inability of the railroad to get material delivered when needed may prove sufficiently great to warrant the contractor in maintaining a fairly large stock in reserve. Even though material may be shipped according to instruction, it often becomes so bunched in transit or by virtue of yard congestion that it is not easy to handle within the 48 hours free service allowed. The cost of the probable demurrage charge during the entire construction must then be balanced against the estimated cost of maintaining material piles. In this connection, the possibility of arranging for a credit and debit account with the railroad company, whereby the contractor is credited with cars which he unloads quickly, and charged for cars held over the limit, should be considered. In considering the feasibility of stock piles an investigation should be made of the cost of securing a site for such stock piles, the relative economy of different methods of handling materials, the cost of protecting such materials, and the natural loss in stock piles.

The relative cost of hauling material direct from the cars as compared with that of maintaining stock piles adjacent to the terminal is determined not only by the conditions above enumerated but also to a large extent by the character of the roads between the terminal and the site of the proposed work. An intelligent estimate can be made only when the position and condition of the roads leading to the proposed work are known. This question is further modified by the time of year and the consequent weather conditions which will probably prevail during the time that the material must be hauled. Conditions may arise which make it impossible to haul material during certain seasons of the year.

Cost of Transportation From Station to Improvement Site: The second item of cost in hauling materials is the transportation from the terminal to the site of the proposed work. This is dependent upon the length of haul and the unit cost. The former is the mean or average distance and can be determined accurately, while the latter depends upon the character of the road over which the materials must be hauled, the season of the year during which hauling must be accomplished, and the kind of equipment adopted for hauling. The amount of new subgrade over which the materials must be hauled will also affect the hauling cost considerably, since the haul over this character of surface will be considerably more expensive than that of hauling over an established roadbed even if the latter is not in particularly good condition.

Mention has already been made of the use of the drag in connection with temporary or detour routes for traffic. In this connection it may be well to consider the economy of dragging the road over which materials must be hauled. The nature of the roadbed, the character of the adjacent topography and vegetation, will considerably affect the cost of maintaining a suitable road for the delivery of materials, and should be taken into consideration in making the estimate for this item.

After all of the above conditions have been considered and evaluated, it becomes necessary to determine the relative cost of different methods of transportation, and to determine the one most economical under the influencing conditions. Certain materials, such as rolls of mesh reinforcing, will be hauled in loads which are limited by bulk rather than the weight of the load, and should be so considered in estimating. Sometimes such materials can be added to advantage to full loads of heavier materials.

Cost of Handling Materials at Improvement Site: The cost of handling materials at the site will vary greatly with the method used, which in turn will depend upon the methods permitted under the specifications. If conditions or the requirements of the specifications are such as to necessitate the piling of aggregates on platforms the cost of handling materials will be considerably influenced by the number of piles which will be necessary. In computing the economy of handling materials from platforms as against materials deposited on the subgrade, the labor and depreciation cost of the plank platforms must be balanced against the waste of aggregate due to the fact that the lower portion of every pile of aggregate will become somewhat mixed with the material of the subgrade, and not all of the original yardage will be utilized. Space will not permit a lengthy discussion of the errors affecting economy frequently observed in handling materials at the site of the improvement, but a careful estimate of the cost of hauling materials should take into consideration the feasibility of all methods permissible under the specifications.

Cost of Under-Drainage

Before making the final estimate on the cost of a

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road, the estimator must determine the probable need of under-drains and their cost. This requires a knowledge of the character of the material through which these drains must be placed, as excavation for underdrainage is not, in general, covered by a classification, and the unit cost must be based upon a knowledge of the actual amounts of the various classes of material likely to be encountered. Very often a study of the road and of the exposed formation above and below will disclose valuable information in this connection. It is not always possible to determine beforehand the effect of cutting a hill or changing a grade upon the flow of sub-surface water, but a careful analysis of the probable need and position of all under-drains is essential to an intelligent estimate.

Cost of Finishing the Grade

The cost of preparing and finishing the subgrade will be affected by a number of items, each of which must be investigated before making the final estimate. Where some earth work must be done prior to the final preparation of the subgrade, cost will be affected by: (1) The relative amount of excavation and embankment. (2) The length of haul required to make the embankment, either by using excavated material or material obtained from borrow pits. (3) The availability of borrow at a reasonable price; as well as many other local conditions. In this connection, mention may be made of various minor operations, such as cleaning out ditches, finishing slopes and shoulders, etc., each of which is a small item of cost, but which, collectively, represent a sum large enough to be well worth careful consideration. The cost of the final preparation of subgrade will be affected by a large number of factors, such as the character of material composing the subgrade proper, the susceptibility of such material to consolidation by rolling, the position and condition of old trenches and of soft or spongy spots that seem likely to outcrop in a finished subgrade.

The season of the year during which the subgrade must be consolidated will greatly affect the cost. During spring and early summer much expensive delay will occur, due to the fact that the subgrade will not be in good condition to consolidate. On the other hand, in arid or semi-arid regions, during the dryer months of the year, it may be necessary to sprinkle the subgrade frequently, and the cost of water for this operation must be estimated in advance. As much as 15 gallons of water per square yard of concrete road surface may be used for wetting the subgrade, and where water must be pumped or hauled this item of expense is considerable.

Cost of Materials

Cement: Cement is usually received in cloth sacks, and the estimated cost for cement should include the net cost of the cement, plus the cost of hauling and returning the sacks to the mill. In addition, an allowance of 15% should be made for sacks which will become lost or torn. The cost of protecting the cement should be considered in this connection. This item will vary considerably with the method used in hauling materials. Where conditions permit, it may prove economical to haul cement direct from the cars, thus necessitating the protection of only a few sacks. In other cases, it may be necessary to provide damp-proof storage for a large quantity of cement. The economical number of storage sheds on the work will vary with the methods of transporting the cement from the storage sheds to the mixer.

Cost of Aggregate: In addition to the first cost the allowance for aggregates should include loss due to handling. This will depend upon the length of haul, character of road and the methods employed in hauling, and will ordinarily vary from 5 to 10%. The loss in handling at the railway terminal and at the work will depend upon the method of handling, but the total loss will rarely be less than 5 and may reach 15%.

Cost of Water: The cost of this item is often overlooked by estimators, although it may be considerable. In a report to the preceding Conference the large amount of water which has been found necessary under certain conditions was emphasized. Where water is pumped, the unit cost will depend upon the length of pipe-line required, the size of pipe, and the pressure needed. A frequent economic mistake is made in trying to pump against a relatively large static head with too small a pipe or too small a pump. This results in constant pump trouble, and consequent delay at the mixer, reducing the efficiency of the mixing crew and retarding the work.

Cost of Miscellaneous Material: Under this head, attention may be called to the cost of a number of minor items, such as joint fillers, reinforcing, depreciation, and interest charges on equipment. Much of the smaller equipment, tools, etc., should be charged entirely to the one piece of construction, as the depreciation and loss on such items will be high. On all other equipment, interest and depreciation may be estimated.

Cost of Placing Materials

The three items which go to make up the cost of placing materials are: Interest and depreciation on equipment, the amount and character of labor necessary for the performance of each item of work, and the unit cost of labor. Interest and depreciation on equipment have been discussed under the head of 'Materials.'

The amount of labor necessary for the performance of the work will be considerably modified by the methods adopted in placing and handling the men. A discussion of the relative merits of different methods of arranging the work is not warranted in a report of this character, further than to emphasize the importance of an analysis of labor cost carried far enough to take into account the various methods of placing the men, and the relative efficiency and cost of different methods of handling the labor on the work.

The unit cost of labor will be modified by a large

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number of conditions. The availability of labor in a community must be given careful study, particularly when industries are running at full capacity and when much of the foreign floating population is returning to Europe. The price of labor will be greatly influenced by the character and number of labor-employing industries in the vicinity. Legal restrictions, such as minimum-wage and maximum-hour laws, state insurance and compensation laws, together with local ordinances, will affect the labor market vitally. For country highway work, legal restrictions in an adjacent municipality may operate by competition to regulate the labor cost, as it is impossible to hold labor at a less wage than they can obtain in a nearby community.

The situation of the improvement with reference to boarding and housing facilities for the men will materially modify the labor cost. When it is not possible to obtain board and lodging for the labor at farm houses in the vicinity of the work, it becomes necessary to calculate the cost of labor camps. An estimate of the cost of labor camps requires a knowledge of the legal restrictions which are placed upon them in some States, such for example as a restriction on the minimum number of cubic feet allowed for each inhabitant of the camp. The sanitation of these camps is often under the inspection of the state board of health and compliance with its regulations may increase the camp cost. The question of water supply for the labor camp must also be given consideration. In some cases this is a considerable item of expense.

Cost of Carrying Securities

The availability of funds for payment for the work will materially affect the ultimate cost. Where counties have had difficulty in disposing of bonds, contractors, in many cases, have had to accept warrants which bear interest at the rate of about 6%, but which the banks in many cases will cash only at from 5 to 10% discount.

It is only just to the contractor to advise him fully concerning the availability of funds in payment of the work and to include the cost of carrying securities as a part of the estimate.

Miscellaneous Expense

In addition to the items of expense which have been discussed above, there are many others which vary widely with local conditions. Among these may be mentioned cost of insurance on equipment, loss due to rain, railroad blockades, inability to get materials, muddy roads, equipment trouble, labor scarcity, idle equipment and teams, and many other items which go to make up a portion of the overhead or arbitrary expense of the construction. The above items will enter into the cost regardless of whether the work is done by contract or by force account. The additional item of superintendence must be added for force-account work, while for contract work, the contractor's profit presumably covers this amount.

DIESEL ENGINES FOR POWER-PLANTS

By CHARLES LEGRAND

*At the Burro Mountain Copper Co.'s plant at Tyrone, New Mexico, are two 5-cylinder, 2-cycle Diesel oil engines, the largest stationary engines of their type in the United States, operating at an altitude of 5950 feet. They drive, direct-connected, two 815-kva., 60-cycle, 3-phase, 6600-volt, 180-r.p.m. generators. The current is used for hoisting ore, driving air-compressors, electric locomotives, and a 1500-ton concentrating plant 3½ miles distant. The load is extremely variable.

These engines are of the vertical design, rated at 1250 b.hp. at sea-level. The cylinders are 20.6-in. diam., with 26-in. stroke. Each engine has a scavenging cylinder of 41.25-in. diam. and 23.6-in. stroke; also a 3-stage, 4-cylinder, high-pressure vertical compressor, both directly connected to the engine. This compressor delivers the air necessary for fuel injection and for starting the engine. The scavenging pump, which is larger than usual, delivers air to blow-off the products of combustion and fill the cylinders with fresh air at the beginning of the stroke. This pump was increased in size to be able to fill the cylinders with air at 2½-lb. gauge pressure at the beginning of the stroke. This gives nearly the same initial absolute pressure, and allows the engine to generate nearly the same indicated horse-power as it would at sea-level. The work done in the scavenging pump is, however, increased and the horse-power available is approximately 95% of sea-level output. The fuel consumption per horse-power is increased over sea-level conditions on account of the extra work of the scavenging pump, and the resulting lower mechanical efficiency of the engine when operating at the elevation above sea-level of this plant.

Fuel used is California asphaltum base oil, averaging 16°B. and 18,360 B.t.u., costing $1.85 to $1.98 per barrel. This is heated to 120°F. Oil of 25°B. is used at the start. Consumption of oil is about 0.78 lb. per kw.-hour on an average.

The cost of power, based on total power generated less that used for auxiliaries in power-plant in May 1916 was $0.0080935 per kw.-hour available. The load factor is 0.62.

Operation of the engines in parallel is satisfactory, even when the load is light. In actual operation, with one engine in service, the peak load carried has been higher than was expected.

The greatest trouble with the engines, not due to carelessness, is with the helical gears driving the cam-shaft. The amount of lubricating oil consumed is being reduced, while the maintenance charge is also expected to come lower. On the whole, operation of the plant has been satisfactory, and the cost is considerably better than with a steam plant of the same capacity run under similar conditions, amply justifying the extra investment for this type of engine where the cost of fuel-oil is high.

*Abstract of paper written for Arizona meeting of the American Institute of Mining Engineers.

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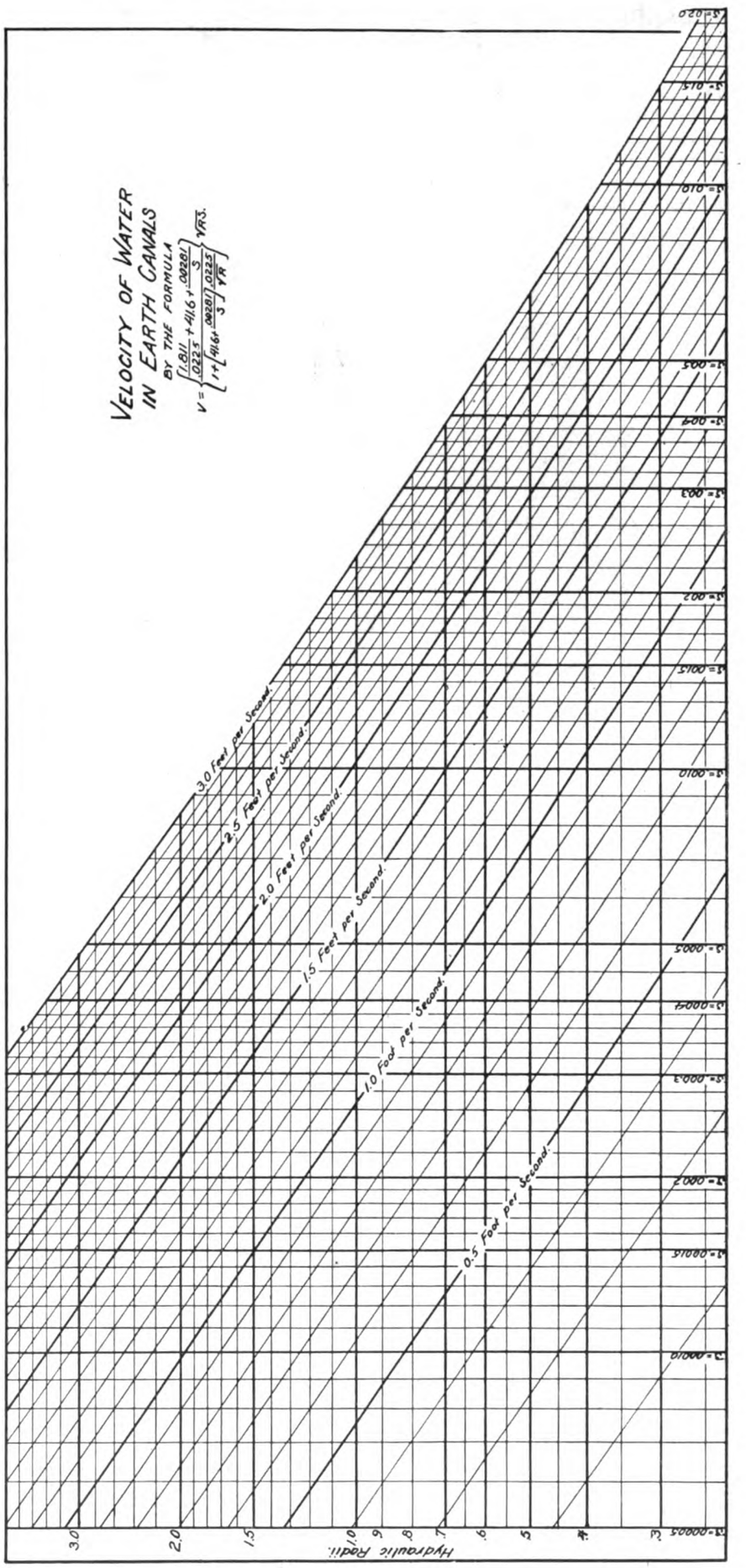
Engineers' Note Book

CHART FOR DETERMINING VELOCITY IN EARTH CANALS

By GEORGE HENRY ELLIS*

The accompanying chart may be used for computing the velocity in unlined earth ditches having hydraulic radii up to 3.5, and with slopes from 0.00005 or about 3 in. to the mile, up to 0.02 or 105.6 ft. to the mile. Thus for a hydraulic radius of 2, and a slope of 0.0001, or approximately 6 in. to the mile, the velocity is found to be slightly over 1 ft. per second.

Velocities exceeding 3 ft. per second are not given, since even this velocity will result in an objectionable amount of erosion in most earthy materials. The value of n in Kutter's formula is taken as 0.0225, on the authority of Bulletin No. 194 of the U. S. Department of Agriculture which gives this value for the reason that it has long been used for this type and the tests do not disclose any reason for changing. This value for the average well-constructed canal in material which will eventually have a medium smooth bottom, with graded gravel, grass on the edges and average alignment or silt on both sides of the bed and scattered stones in the middle, or a smooth bottom with an average amount of grass and rocks forming the sides. Hardpan in good condition, clay and lava-ash soil takes about this value.



Book Reviews

STEAM POWER. By C. F. Hirshfeld and T. C. Ulbricht. Third edition. P. 420. Ill., index. John Wiley & Sons, New York, 1916. For sale by the *Mining and Scientific Press*, San Francisco. Price, $2.

While essentially an elementary work on the steam engine and accessories, for colleges and technical schools, power-plant engineers will find it of value on many points. The matter is up to date, including as it does notes on the latest boilers, stokers, and turbines. The physical conceptions and units, and discussion on steam are well given. Various types of engines are described. Combustion is explained in a practical manner, also recovery of waste heat. The illustrations have been well selected. Altogether, the book is worth the price.

BOLETIN DEL PETROLEO. Organo de la Secretaria de Fomento. Office, 2 A Calle de Tacula No. 7, Mexico City. A. G. Perez, administrator. Price ₱18 per annum, or ₱10 per half-year. Issued twice a month. This is an official publication dealing with the oil industry of Mexico. The August number consists of 112 pages, with illustrations and statistical matter.

*Fort Shaw, Montana.

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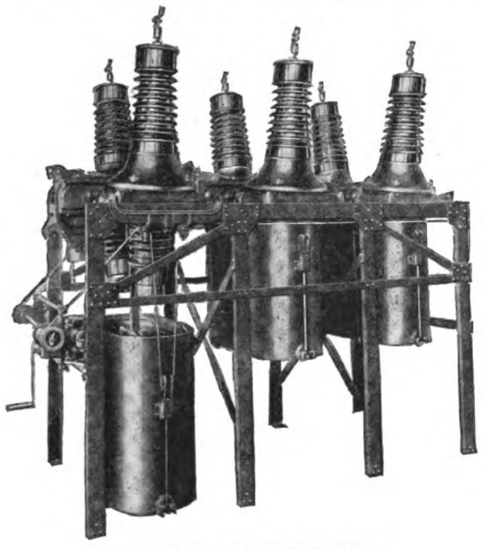
LARGE-CAPACITY TANK-TYPE CIRCUIT-BREAKERS

The main changes that have been made recently in tank-type oil-break circuit-breakers manufactured by the General Electric Co. have been to make the breakers more accessible for inspection and repair. No radical departure in the design of the current-carrying or operating parts has been necessary. Indoor and outdoor breakers are similar. The only difference consists of the addition of a few parts to enable the outdoor breaker to be serviceable both from a mechanical and an electrical standpoint under all weather conditions. The K-21



TANK-TYPE CIRCUIT-BREAKER.

and K-26 breakers are used indoors on voltages from 35,000 to 150,000, and the K-22 and KO-26 are used on outdoor work from 22,000 up to 150,000 volts. The K-22 is like the K-21, except that the K-22 has outdoor bushings and the mechanism is protected from the weather by an iron housing. The KO-26 shown in the illustration is like the K-26, except weatherproof covers and bushings are used for outdoor installations.

The breakers except those for 110,000 volts and over, can be mounted on a framework. The tanks are handled by a lifting device recently perfected. The lifter consists of a detachable frame with shaft, handle, worm-gear and winding and unwinding-drums. The advantage of this equipment is that it allows a tank to be removed or placed in position without difficulty. The device is readily detached and can be moved by one man from one switch to another, thus making it a simple operation to lower or raise an oil tank, and also making it easy to inspect the contacts and oil, and replace contacts if necessary.

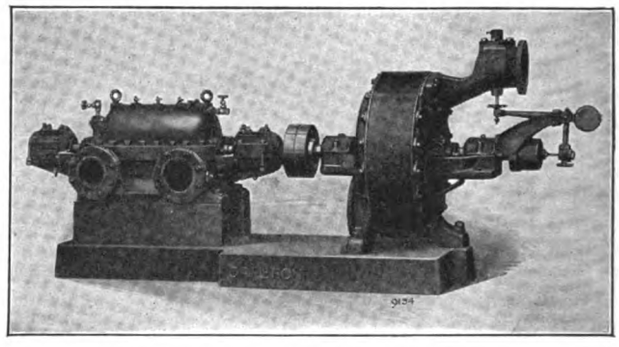
These top-connected circuit-breakers are self-contained for use on systems with potentials up to and including 200,000 volts. One tank with two breaks in series is used in each phase. The breakers are made for either automatic or non-automatic operation. They are closed by hand, solenoid, or air, and the automatic breakers are tripped under overload by series-trip coils or current transformers. For hand operation, the breakers can be installed behind the switchboard panel with the operating handle in front and connected to the breakers by connection-rods and bell-cranks. When solenoid or air-operated, the breakers may be placed where desired and may be controlled from the switchboard or other convenient place by a pull control-switch or air-valve. The operating mechanism and bushings are secured to the cast-iron cover of the heavy sheet-steel tank. Each bushing extends through the switch cover into the oil, and is so clamped to the cover that the throwing of oil is impossible.

There are two fixed contacts in each switch element, between which one phase of the circuit is made and broken by a horizontal contact-blade. Each contact-blade is connected to the operating mechanism by a specially tested hard wooden rod, which passes through the cover of the switch in an insulating bushing. The stationary contacts consist of widely flared fingers and long arcing tips of drop-forged copper secured to the contact block by flat steel springs, copper laminations, and screws. The contacts are always smooth and bright due to the sliding effect resulting from opening and closing and the arrangement of the burning-tips. The oil tanks are constructed of sheet steel.

AN IMPROVED CENTRIFUGAL PUMP

Development of the steam turbine and high efficiency multi-stage centrifugal pump has progressed together, but so far it has not been entirely practicable to reconcile the speeds of the two machines so that each would work at its best efficiency. Heretofore it was necessary to reduce the speed of the turbine and sacrifice much of its efficiency or else speed up the pump with similar results. To overcome this difficulty the Cameron Steam Pump Works of New York has designed and built a multi-stage centrifugal known as the 'B-T' type.

The accompanying electro shows a completely assembled



CENTRIFUGAL PUMP AND STEAM TURBINE.

pump and engine. The speed feature is a virtue of the impeller design. With the ordinary impeller the diameter cannot be reduced sufficiently to get high speed without sacrificing vane length, and consequently efficiency for a certain vane length is necessary in order that the impeller may perform its function without excessive loss. Small external diameter and adequate vane length are obtained in this pump, by bringing the vanes well down into the impeller hub, at the same time so turning them that the incoming water is guided smoothly, and with little loss into the outer portion of the vanes where the velocity is generated that is finally converted into useful pressure by means of the external diffusion vane. Additional advantages in the small impeller are light weight and low fibre stresses in the material. Each impeller is cast solid in one piece and is of the enclosed type. The casing is divided along the horizontal centre line. Both the suction and discharge connections are in the lower half of the casing. The upper half is readily removable, giving full access to the revolving element. There are suitable openings for draining the pump and for displacing the air when starting. Inlet and outlet nozzles can be arranged either on the same or opposite sides, an important advantage where pumps are installed in limited space. The shaft is made of high-grade forged steel, and wherever it comes in contact with the fluid being pumped it is thoroughly protected by bronze sleeves. To take care of thrust, which manifests itself in all multi-stage pumps, this pump is equipped with a simple internal hydraulic balancing-device.

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Personal

C. C. VAN VALKENBURGH has been appointed assistant city engineer of Fresno, California.

L. A. GRANGER, formerly assistant city engineer of Fresno, California, has resigned to enter private practice in that city.

A. N. JOHNSON, chief engineer for the Portland Cement Association, with headquarters at Chicago, is making a tour of the Pacific Coast.

WENDELL M. JONES has been appointed assistant hydrographer for the U. S. Reclamation Service, with headquarters at Spanish Fork, Utah.

E. C. LARUE, hydraulic engineer for the U. S. Geological Survey, with headquarters at Salt Lake City, has been assigned to special water-power investigations in Oregon.

F. T. CROWE, formerly construction manager for the U. S. Reclamation Service, has been appointed manager for the Flathead project, with headquarters at St. Ignatius, Montana.

E. A. WALCOTT, secretary of the Commonwealth Club of California, addressed the members of the Engineers' Club of San Francisco, September 14, on 'The Operation of Civil Service in San Francisco.'

JAMES MORSE, formerly manager for the Morse Construction Co., has been appointed superintendent of roads for San Diego county, California. Mr. Morse has built over 100 miles of highway in that county.

The following additional deputies have been appointed by R. P. MCLAUGHLIN, state oil and gas supervisor for California: R. N. FERGUSON, with headquarters at Bakersfield; J. H. DOUGHERTY at Taft, and R. D. BUSH at Coalinga.

E. B. LATHAM, formerly deputy oil and gas supervisor at Santa Maria and Taft, California, is with the U. S. Coast and Goedetic Survey with headquarters at Washington, D. C. He is now engaged in a re-survey of the harbor of San Diego.

F. H. OLMSTED, of Olmsted & Gillelen, consulting engineers of Los Angeles, has been appointed engineer in charge of Federal investigations of the flood problem on the Gila river, in Graham county, Arizona. The work is being financed by a $10,000 Congressional appropriation.

New Publications

MONTHLY JOURNAL UTAH SOCIETY OF ENGINEERS, August 1916.

SAFETY BULLETIN, September, 1916. Bureau of Safety, 72 West Adams street, Chicago. P. 16. Illustrated.

CONCRETE SWIMMING AND WADING POOLS. P. 18. Ill. Portland Cement Association. Gives rules for design and construction.

CONCRETE LININGS FOR IRRIGATION CANALS. P. 15. Ill. Portland Cement Association. Discusses methods used in lining canals with concrete, also the construction of concrete pipe.

CONCRETE SEWERS. P. 43. Ill. Portland Cement Association, 111 West Washington street, Chicago. Gives brief summary of data regarding the design, construction, and use of concrete sewers.

DEPENDABLE CONCRETE. Bulletin A-2, The National Lime Manufacturers Association, Pittsburg. P. 14. Ill. Gives data regarding the use of hydrated lime in all classes of concrete construction, together with examples from actual practice.

CORRECTION OF ECHOES AND REVERBERATION IN THE AUDITORIUM, UNIVERSITY OF ILLINOIS. By F. R. Watson and J. M. White. P. 20. Ill. University of Illinois Engineering Experiment Station, Urbana, Illinois. The principal means used for improving conditions was lining a large part of the walls and ceiling with hair-felt.

TRIANGULATION IN COLORADO, UTAH, IDAHO, MONTANA, AND WYOMING, Bulletin 644-D, TRIANGULATION IN NEVADA, Bulletin 644-M, TRIANGULATION AND PRIMARY TRAVERSE IN OREGON, Bulletin 644-O, TRIANGULATION AND PRIMARY TRAVERSE IN WASHINGTON, Bulletin 644-Q. United States Geological Survey, Washington, D. C. These four pamphlets will be of great service to engineers making accurate surveys in the territory covered.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

Coming Conventions

AMERICAN ELECTRIC RAILWAY ASSOCIATION. Annual convention, Atlantic City, New Jersey, October 9-13. E. B. Burritt, secretary, 8 West 40th street, New York.

AMERICAN GAS INSTITUTE. Annual meeting, Chicago, October 17-20. G. G. Ramsdell, secretary, 29 West 39th street, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Annual convention, Newark, New Jersey, October 9-13. Charles C. Brown, secretary, Indianapolis, Indiana.

INTERNATIONAL IRRIGATION CONGRESS. Annual Convention, El Paso, Texas, October 14-18. Arthur Hooker, secretary, El Paso, Texas.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION. Annual Convention, Terre Haute, Indiana, October 5-6. Will P. Blair, secretary, Cleveland, Ohio.

Commercial Paragraphs

The FOUNDATION CO. of New York has opened a district office at 58 Sutter street, San Francisco. This company makes a specialty of the sinking of deep foundations for bridges and all classes of heavy structures, both by the open and the pneumatic method.

The BRENNAN ENGINEERING CO. has incorporated under the name of the Brennan Wahl Co., mechanical, structural, and chemical engineers, also sales and purchasing agents, with offices in the Delaware Bdg., Chicago. The officers of the company are Daniel A. Brennan, president; Andrew G. Schneider, vice-president, and Henry R. Wahl, secretary and treasurer.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN $4.50 per Year

SAN FRANCISCO, OCTOBER 2, 1916

SINGLE COPIES WEEKLY NEWS BULLETIN 15 Cents

Contracts Pending

Bids will be Received			See Issue of News Bulletin
Oct.	2.	Anaconda, Mont., Street Work	Oct. 2
Oct.	2.	Los Angeles, Cal., Bridge	Oct. 2
Oct.	2.	Los Angeles, Cal., Sewers	Oct. 2
Oct.	2.	Los Angeles, Cal., Street Work	Oct. 2
Oct.	2.	San Fernando, Cal., Street Work	Oct. 2
Oct.	2.	Underwood, Wash., Irrigation	Oct. 2
Oct.	2.	Vallejo, Cal., Street Work	Oct. 2
Oct.	3.	Hillsborough, Cal., Street Work	Sept. 25
Oct.	3.	Los Angeles, Cal., Drainage	Sept. 25
Oct.	3.	Marysville, Cal., Bridges	Sept. 25
Oct.	3.	Modesto, Cal., Building	Sept. 11
Oct.	3.	Oroville, Cal., Bridges	Sept. 18
Oct.	3.	Phoenix, Ariz., Street Work	Oct. 2
Oct.	3.	Red Bluff, Cal., Road Work	Sept. 18
Oct.	3.	Sacramento, Cal., Railroad Work	Oct. 2
Oct.	3.	Salinas, Cal., Bridge	Sept. 25
Oct.	3.	Salinas, Cal., Road Work	Sept. 25
Oct.	3.	Salt Lake City, Utah, Sewer	Oct. 2
Oct.	3.	San Francisco, Cal., Miscellaneous	Oct. 2
Oct.	3.	Santa Rosa, Cal., Bridge	Sept. 25
Oct.	3.	Santa Rosa, Cal., Road Work	Sept. 25
Oct.	3.	Santa Rose, Cal., Supplies	Oct. 2
Oct.	3.	Seattle, Wash., Bridge	Sept. 18
Oct.	3.	Stockton, Cal., Road Work	Sept. 18
Oct.	3.	Sunnyvale, Cal., Street Work	Sept. 25
Oct.	3.	Willows, Cal., Bridges	Sept. 18
Oct.	4.	Bakersfield, Cal., Building	Sept. 25
Oct.	4.	Enumclaw, Wash., Drainage	Oct. 2
Oct.	4.	Riverside, Cal., Road Work	Oct. 2
Oct.	4.	San Diego, Cal., Bridges	Sept. 18
Oct.	4.	San Diego, Cal., River Work	Sept. 25
Oct.	4.	San Leandro, Cal., Street Work	Sept. 25
Oct.	4.	San Francisco, Cal., Miscellaneous	Sept. 25
Oct.	4.	San Francisco, Cal., Street Work	Oct. 2
Oct.	4.	San Francisco, Cal., Water Supply	Oct. 2
Oct.	4.	Santa Ana, Cal., Road Work	Sept. 18
Oct.	4.	Santa Ana, Cal., Street Work	Sept. 25
Oct.	5.	Berkeley, Cal., Street Work	Oct. 2
Oct.	5.	Oakland, Cal., Building	Oct. 2
Oct.	5.	Oakland, Cal., Street Work	Oct. 2
Oct.	5.	Oakland, Cal., Street Work	Sept. 25
Oct.	5.	Sacramento, Cal., Building	Sept. 18
Oct.	5.	Spokane, Wash., Supplies	Oct. 2
Oct.	6.	Oakland, Cal., Street Work	Sept. 25
Oct.	7.	Merced, Cal., Building	Oct. 2
Oct.	7.	Red Bluff, Cal., Bridge	Sept. 25
Oct.	9.	Cle Elum, Wash., Light	Oct. 2
Oct.	9.	Martinez, Cal., Road Work	Sept. 21
Oct.	9.	North Yakima, Wash., Road Work	Oct. 2
Oct.	9.	Olympia, Wash., Road Work	Sept. 25
Oct.	9.	Oroville, Cal., Road Work	Oct. 2
Oct.	9.	Sacramento, Cal., Bridges	Oct. 2
Oct.	9.	Sacramento, Cal., Road Work	Oct. 2
Oct.	9.	Sacramento, Cal., Road Work	Sept. 18
Oct.	9.	San Bernardino, Cal., River Work	Sept. 25
Oct.	9.	South San Francisco, Cal., Street Work	Oct. 2
Oct.	10.	Chino, Cal., Street Work	Oct. 2
Oct.	10.	Eureka, Cal., Road Work	Oct. 2
Oct.	10.	San Jose, Cal., Building	Oct. 2
Oct.	10.	St. Ignatius, Mont., Irrigation	Sept. 18
Oct.	10.	Washington, D. C., Supplies	Oct. 2
Oct.	11.	Los Angeles, Cal., Machinery	Oct. 2
Oct.	11.	Oakland, Cal., Sewer	Oct. 2
Oct.	11.	Oakland, Cal., Street Work	Oct. 2
Oct.	12.	San Bernardino, Cal., Building	Sept. 25
Oct.	12.	Washington, D. C., Machinery	Oct. 2
Oct.	14.	Ventura, Cal., Bridge	Oct. 2
Oct.	14.	Ventura, Cal., Street Work	Oct. 2
Oct.	14.	Ventura, Cal., Supplies	Oct. 2
Oct.	16.	San Jose, Cal., Bridges	Sept. 25
Oct.	16.	Upland, Cal., Culvert	Sept. 25
Oct.	17.	Hermosa Beach, Cal., Sewer	Oct. 2
Oct.	21.	Los Angeles, Cal., Water Supply	Oct. 2
Oct.	23.	Seattle, Wash., Irrigation	Oct. 2
Nov.	11.	Washington, D. C., Machinery	Oct. 2
Dec.	6.	Portland, Ore., Bridge	Sept. 25

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

SEPTEMBER 21

One Story Frame Dwelling—Cost $2500. G. Cademartori, owner. NW Ruth and Watson Place.

Two Story Frame Flats—Cost $6680. Hugh Reilly, owner. W Dolores 28 S 21st.

Foundation for Building—Cost $4500. J. J. Trynan, owner. SE Lyon and Vallejo.

Two Story Frame Dwelling—Cost $2500. F. Nelson, owner. W 27th Ave 233 N Irving.

Two Story Frame Dwelling—Cost $3000. Natale Mulo, owner. S Pfeiffer 180 W Grant Ave.

One Story Brick Repair Shop—Cost $5000. F. H. Guntz, owner. E Dolores 140 N 14th.

Two Story Frame Dwelling—Cost $3400. S. A. Born Building Co., owner. Lincoln Manor, Lot B.

Two Story Frame Dwelling—Cost $2500. John J. Lane, owner. E Collingwood 100 S 21st.

Four Two Story Frame Dwellings—Cost $2900 each. Emil Nelson, owner. E 15th Ave 26, 41, 76, and 101 S Balboa.

SEPTEMBER 22

Two Story Frame Flats—Cost $5000. Wm. Schonberg, owner. 269 Chattanooga.

Three Story Frame Flats—Cost $9610. E. B. Jorgenson, owner. E 22nd Ave 140 S California.

Two Story Frame Dwelling—Cost $2650. J. J. Kingwell, owner. E 24th Ave 175 S Geary.

(Continued on page 407.)

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Construction News

STREET AND ROAD WORK

Anaconda, Mont.—Bids will be received until October 2 by M. J. Kelly, city clerk, for construction of pavement and curbs in district No. 90. Work includes about 13,500 sq. yd. of pavement.

Berkeley, Cal.—Bids will be received until October 5 by A. G. Briggs, city clerk, for grading and construction of brick pavement on concrete base, concrete curbs, storm-water inlets, and cast-iron and concrete culverts on Euclid avenue and on Vine street.

Contract for construction of asphalt pavement on concrete base and concrete curbs and gutters on Fulton street has been awarded to Oakland Paving Co., 5000 Broadway, Oakland.

Chino, Cal.—Bids will be received until October 10 by E. L. P. Wetmore, for improvement of several streets. Estimated cost is $73,000.

Eureka, Cal.—Bids will be received until October 10 by Fred M. Kay, county clerk, for construction of highway embankment across marsh near Arcata.

Fowler, Cal.—Cornfield & Davis, Bakersfield, were low bidders at $7750 for paving state highway through city. Other bidders were: W. A. Kettlewell & Sons, $8706.20; Thompson Bros., $8681.59; George Shannon, $8846.

Lindsay, Cal.—Contract for improvement of several streets has been awarded to Worswick Construction Co., Los Banos.

Los Angeles, Cal.—Board of Public Works will receive bids until October 2 for the following street work: grading, oiling, and construction of concrete curbs, gutters, and sidewalks on Cove avenue; asphalt pavement, brick and granite-block gutters, concrete curbs and sidewalks, and vitrified pipe sewers on 18th street; concrete curbs and sidewalks on Clay street; asphalt pavement, concrete curbs and sidewalks, and granite block and brick gutters on Boyle avenue; grading, oiling, and construction of concrete curbs, sidewalks, and gutters on Monroe street; grading and oiling on Alvarado street; concrete curbs and sidewalks on New Hampshire avenue; grading and construction of asphalt pavement, concrete curbs and sidewalks, and granite-block gutters on Mission road.

Contract for improvement of De Longpre avenue has been awarded to George R. Curtis, 2052 East 37th street, for $7417.16.

Mansfield, Wash.—All bids for paving certain streets have been rejected and a new call for bids will be issued soon. Estimated cost is $15,000.

North Bend, Ore.—Contract for paving highway along waterfront has been awarded to Dean & Brown for $28,054.69.

North Yakima, Wash.—Bids will be received until October 9 by C. E. Barrett, county auditor, for grading and graveling permanent highway No. 21 and grading and graveling Parket Bottom road.

Oakland, Cal.—Bids will be received until October 5 by L. W. Cummings, city clerk, for construction of concrete sidewalks adjacent to several schools.

Bids will be received until October 11 by L. W. Cummings, city clerk, for grading and construction of concrete pavement on part of Foothill boulevard.

Contract for construction of reinforced concrete pavement on fill along San Lorenzo creek at A street has been awarded to Western Construction Co. for $4140.50. Other bidders were: M. E. Fernandez, $4256; P. Mathiesen, $4642; T. B. Russell, $4747; H. M. Dain, $5513.

Contract for placing oil and screenings on part of Redwood highway has been awarded to Western Construction Co. for $1338. A. H. Kopperud bid $1833.40 and P. H. Hoare, $2317.50.

Contract for improvement of Fairfax avenue has been awarded to Hutchinson Co., 13th and Franklin streets, at the following unit prices: excavation, $0.18 per cu. yd., redwod curbs, $0.09 per ft.; concrete gutters, $0.12 per sq. ft.; oil-macadam pavement, $0.07 per sq. ft.; concrete sidewalks, $0.09 per sq. ft.; 10-in. conduit, $0.85 per ft.; 16-in. conduit, $1 per ft.; 1½ by 2½-ft. concrete culvert, $3.20 per ft.; brick manholes, $35 each; concrete manholes, $35 each; cast-iron inlets, $25 each.

Oroville, Cal.—Bids will be received until October 9 by C. F. Belding, county clerk, for improvement of Oroville-Palermo highway.

Petaluma, Cal.—Bond issue of $75,000 for paving Third street and Main street and for improvement of Thompson creek failed to receive the necessary two-thirds majority.

Phoenix, Ariz.—Bids will be received until October 3 by Frank Thomas, city clerk, for improvement of several streets.

Portland, Ore.—Contract for paving approaches to interstate bridge over Columbia river has been awarded to Warren Construction Co. at $93,386.70 for bitulithic pavement on crushed-rock base.

Riverside, Cal.—Bids will be received until October 4 by A. B. Pilch, county clerk, for construction of one mile of concrete pavement on highway near Beaumont.

Sacramento, Cal.—Bids will be received until October 9 by State Highway Commission for grading highway in Sonoma county between Cotati and Petaluma, 3.6 miles. Work includes 39,000 cu. yd. excavation without classification, 942 ft. of 12 to 30-in. corrugated metal pipe, and 370 cu. yd. class B concrete in culverts and monuments. Commission will furnish pipe railing for culverts, reinforcing steel, corrugated metal pipe, cement, sand, and coarse aggregate. Plans at office of Commission or at offices of division engineers in San Francisco and Los Angeles. Copies of plans may be obtained from Commission upon payment of $1.22 for plans and $4.05 for cross-sections. Checks should be made payable to Forrest Blue Print Company.

Construction of state road from Truckee to Nevada line is proposed, also construction by State of Nevada of road from this point to Reno. George A. Raymer, Reno, is interested.

Contract for improvement of alley north of First avenue has been awarded to W. J. Tobin, 735 Filbert street, Oakland.

Contract for improvement of alley between F and G streets has been awarded to J. W. Terrell.

San Anselmo, Cal.—Contract for improvement of street in Upper Bush tract has been awarded to Western Motor Draying Co., 1444 Church street, San Francisco, for $9118.70. D. O. Church Co. bid $9498.59.

San Fernando, Cal.—City clerk will receive bids until October 2 for improvement of Hagar street.

San Francisco, Cal.—Board of Public Works will receive bids until October 4 for the following street work: asphalt pavement and concrete curbs for one block on 20th avenue; sidewalks for one block on 19th avenue; asphalt pavement, concrete curbs and sidewalks, and 10-in. vitrified pipe sewer for one block on Balboa street; similar improvements for one block on Anza street and for four blocks on 20th avenue, and for construction of asphalt pavement on parts of Division street and 10th street.

Santa Barbara, Cal.—Paul & Caldwell, Stockton, were awarded contract for improvement of 2½ miles of Mission Ridge highway at $53,327.50. Other bidders were: Bradshaw-Barnes Co., $54,183.16; E. A. Garland, $55,270.72; F. R. Ritchie, $57,323.53; Modern Construction Co., $67,879.77. Engineer's estimate was $53,324.

Contract for construction of 2500 lin. ft. of concrete road on Ralph Isham place has been awarded to E. A. Hunt.

Santa Paula, Cal.—Contract for construction of 220,000 sq. ft. of pavement has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles.

South San Francisco, Cal.—Bids will be received until October 9 by W. J. Smith, county clerk, for grading and construction of concrete pavement on several alleys.

Vallejo, Cal.—Bids will be received until October 2 by A. E. Edgcumbe, city clerk, for grading and construction of asphaltic concrete pavement on concrete base and corrugated-iron culverts on Florida street.

Ventura, Cal.—Bids will be received until October 14 by J. B. McCloskey, county clerk, for construction of 24,400 sq. ft. of oil macadam pavement in town of Hueneme.

Wenatchee, Wash.—Contract for construction of two miles of Scenic highway has been awarded to Quigg Construction Company.

SEWERS AND DRAINAGE

Anaconda, Mont.—Contract for construction of Third street storm-sewer has been awarded to Clifton, Applegate & Tooele for $49,971.

College City, Cal.—Following contracts have been awarded to local contractors for drainage work in reclamation district No. 108: 75,000 cu. yd. excavation to W. T. Wilkins & Son; 42,000 cu. yd. excavation to Asa Kalfsbeek. Contract for 25,000 cu. yd. excavation has been awarded to Tom Woodward, Knights Landing.

Enumclaw, Wash.—Bids will be received until October 4 by Shorett, McLaren & Shorett, New York Block, Seattle, for draining 1000 acres in drainage district No. 5. Work includes 16,000 cu. yd. excavation. Estimated cost is $10,000.

Hanford, Cal.—Plans for reclamation of overflowed land in

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Tulare lake have been proposed. Plans include canal 1500 ft. wide on 192-ft. contour to carry flood-waters. D. W. Lewis, Corcoran, is interested.

Hermosa Beach, Cal.—Bids will be received until October 17 by B. F. Brown, city clerk, for construction of sewage-disposal plant including 320 cu. yd. concrete, 1800 ft. of 8-in. cast-iron pipe, 830 ft. of 12-in. vitrified pipe, 1380 ft. of reinforced concrete pipe, 700 ft. of 5½ by 7-ft. tunnel, two air-compressors, two 100-gallon sewage ejectors, motors, and building.

Los Angeles, Cal.—Board of Public Works will receive bids until October 2 for construction of sewers on 21st street in San Pedro and on 42nd street.

Oakland, Cal.—Bids will be received until October 11 by L. W. Cummings, city clerk, for construction of 8-in. vitrified pipe sewer on Whittle avenue.

Salt Lake City, Utah.—Bids will be received until October 3 by Gordon Snow, city recorder, for construction of sewer on Douglas street. Plans from S. Q. Cannon, city engineer, upon deposit of $5.

Stockton, Cal.—Contract for construction of lateral sewers in Mossdale tract has been awarded to W. F. Edwards for $3252.14.

BRIDGES AND CULVERTS

Baker, Ore.—Contract for construction of ten steel bridges in various parts of the county has been awarded to Coast Bridge Co., Portland, for about $12,000.

Los Angeles, Cal.—Board of Public Works will receive bids until October 2 for repairing bridge across Los Angeles river at Macy street.

Nevada City, Cal.—City trustees have decided to construct concrete viaduct over Little Deer creek at Sacramento street. Nevada County Traction Co. will pay half the cost.

Riverside, Cal.—Following bids were received for construction of concrete overhead crossing over Southern Pacific tracks at Banning: Klausman & Elsea, $5004; Munoz & Munoz, $5555; W. M. Ledbetter, $5760; Mesmer & Rice, $5853; Mercereau Bridge & Construction Co., $5999; Kearns & Hicks, $7550. The two lowest bids were taken under advisement.

Sacramento, Cal.—Bids will be received until October 9 by E. F. Pfund, county clerk, for construction of two reinforced concrete bridges, one on the Marysville road and one on Marconi avenue.

San Anselmo, Cal.—Town trustees have approved plans for construction of concrete bridge at Lansdale. Estimated cost is $13,000. Call for bids will be issued soon.

San Diego, Cal.—City will construct bridge at 30th street. Estimated cost is $5000. Work will be done by day labor under supervision of city manager Lockwood.

Ventura, Cal.—Bids will be received until October 14 by J. B. McCloskey, county clerk, for construction of 120-ft. concrete pile bridge on Ojai avenue across San Antonio creek.

Washington, D. C.—Contract for furnishing steel for two bridges on Klamath Indian Reservation, Oregon, has been awarded to Omaha Structural Steel Works, Omaha, Nebraska, for $69,800.

IRRIGATION AND WATER SUPPLY

Brigham City, Utah.—Plans are being prepared for diversion of 12 second-feet of water from Boxelder creek for power purposes. Plans include a dam, 5550 ft. of wood-stave pipe, 400 ft. of riveted-steel pipe, and two water-wheels operating under a head of 293 feet.

Burbank, Cal.—Contract for furnishing 4-in. wrought-iron water-pipe to city has been awarded to Smith-Booth-Usher Co., 228 Central avenue, Los Angeles, for $0.4067 per foot.

Doyle, Cal.—Plans for irrigation system for Southern Lassen irrigation district have been completed. Bond election will be called soon. William Wales, Woodland, is engineer.

Hailey, Ida.—Contract for construction of dam for Blaine County Irrigation Co. has been awarded to Maney Bros & Co., Boise.

Los Angeles, Cal.—Board of Supervisors will receive bids until October 21 for construction of system for water works district No. 2, including 12-in. well 400 ft. deep, deep-well pump to deliver 300 gallons per minute against a head of 90 ft., 3200 ft. of 6-in. and 16,000 ft. of 4-in. wood-stave pipe, and a 50,000-gallon wood-stave tank on a 50-ft. wooden tower resting on concrete piers.

Contract for furnishing riveted-steel pipe for Western Avenue water-main has been awarded to Baker Iron Works for $94,228.11.

Medford, Ore.—Formation of irrigation district containing 6000 acres is proposed. Robert Brevard is interested.

Modesto, Cal.—Waterford irrigation district has agreed to pay $254,000 to Modesto irrigation district for use of its main canal to carry water to Waterford district. Modesto district will use money to enlarge its main canal. A bond issue of $465,000 was voted recently in the Waterford district. The remainder of the money will be used for construction of distribution system. E. N. Bryan is engineer for Waterford district and F. C. Herrmann, Merchants Exchange Bdg., San Francisco, is engineer for Modesto district.

Oakdale, Cal.—Bids are being received by the secretary of the Oakdale irrigation district for widening and concreting canals at Two-Mile Bar. Estimated cost is $10,000. Burton Smith is engineer.

Ogden, Utah.—Joseph M. Tracy, city engineer, has prepared plans for masonry dam and reservoir on south fork of Ogden river.

San Francisco, Cal.—Bids will be received until October 4 by Board of Public Works for construction of high-pressure water-mains in Telegraph Hill district and on several other streets.

Contract for construction of 4-in. flexible-joint pipe-line to Goat Island has been awarded to Thomas Crowley, foot of Howard street, for $19,913.

San Rafael, Cal.—Plans have been completed for purchase of $3,000,000 bond issue of Marin municipal water district by the J. R. Suterlin Co. and J. S. Woody of Kansas City, Missouri. Property of Marin Water & Power Co. will be purchased and temporary dam at Alpine will be constructed immediately.

Santa Cruz, Cal.—Contract for furnishing 14-in. converse lock-joint water-pipe to city has been awarded to Crane & Co. for $1.59 per ft., or $3266.80 in all.

Terra Bella, Cal.—Contract for drilling five test-wells for Terra Bella irrigation district has been awarded to M. P. Bramlet. Contract for drilling a sixth well has been awarded to Western Well Works Co., San Jose.

Underwood, Wash.—Bids will be received until October 2 by H. A. Hussey, secretary Underwood irrigation district, for construction of 2250 ft. of wooden flume.

LIGHT, HEAT, AND POWER

Cle Elum, Wash.—Bids will be received until October 9 by H. F. Hardin, town clerk, for construction of electric-lighting system. Estimated cost is $5000.

San Francisco, Cal.—Contract for furnishing motors, switches, and fuses at Goat Island has been awarded to General Electric Co. for $862.84.

RIVER AND HARBOR WORK

Colusa, Cal.—Following bids were received for raising water-front levee: Antioch Dredging Co., $145 per day of 22 hours for furnishing dredge; Mooney & Boggs, $0.30 per cu. yd. provided city remove trash from levee. Bids were rejected because too high and work will probably be done by day labor.

Eureka, Cal.—Following bids were received for repairing city slip at F street: Humboldt Dredging Co., $359 for construction, and $1.06 per cu. yd. for dredging 600 cu. yd. of mud; Mercer-Fraser Co., $212 for construction and $1.025 per cu. yd. for dredging.

Contract for repairing Murray Street slip has been awarded to Walter Selvage for $148.

Grimes, Cal.—Contract for construction of wharf and concrete retaining wall on river bank has been awarded to J. M. and J. W. Peart, College City, for about $6000.

Newport Beach, Cal.—Bond issue of $125,000 for dredging and construction of jetty at harbor has been voted.

Sacramento, Cal.—Assistant state engineer P. M. Norboe has approved plans for flood-control dam on San Joaquin river near Lathrop. Estimated cost is $2500, which will be divided between the State and the adjacent property-owners.

Santa Ana, Cal.—Contract for construction of 6000 cu. yd. of levee embankment for Newbert protection district has been awarded to W. M. Ward and M. H. Moss for $0.50 per cubic yard.

Bond issue of $31,000 for construction of levees and pile protection in Olive-West Orange storm-water district has been voted.

Seattle, Wash.—Bids will be received until October 23 at U. S. Engineer Office for dredging in Lake Washington canal.

RAILROAD WORK

Baker, Ore.—Contract for eliminating grade crossing at Lime has been awarded to O. H. Clark & Co. for $5800. Contract for eliminating crossing at Weatherby has been awarded to W. L. Boyes for $4123.80.

Sacramento, Cal.—Bids will be received until October 3 by M. J. Desmond, city clerk, for construction of turnout for municipal railroad track on Front street.

San Francisco, Cal.—Panoche Valley Railroad Co. has been granted permission by State Railroad Commission to issue $200,000 in stock and $900,000 in bonds for construction of railroad from South Dos Palos through Panoche valley to Ashurst ranch, 52 miles. H. W. Altman, 1043 South Union street, Los Angeles, is interested.

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Stockton, Cal.—Stockton Terminal & Eastern Railroad has awarded contract for paving tracks to Paul & Caldwell.

BUILDING CONSTRUCTION

Anderson, Cal.—Election will be held December 12 to vote on bond issue of $60,000 for construction of building for high school.

Eureka, Cal.—Contract for construction of Daly apartments has been awarded to Lewis Halvorsen for $35,108.50.

Hollister, Cal.—Contract for construction of reinforced concrete building for Grangers' Union has been awarded to Boyajohn-Arnold Co., Portland, Oregon, for about $50,000.

Honolulu, Hawaii.—Contract for construction of buildings at quarantine station has been awarded to Lord-Young Engineering Co. for $29,647.

Lakeview, Ore.—Jason C. Moore, 39 Cortlandt street, New York City, will construct experimental plant costing $250,000 for extracting salts from Sumner and Albert lakes. If plant is successful an investment of about $6,000,000 will be made.

Los Banos, Cal.—Bond issue of $63,000 for construction of school building has been declared invalid.

Merced, Cal.—Bids will be received until October 7 by W. H. Robinson, clerk of school board, for construction of building for commercial department of high school. Cowell & Bedesen, Shaffer Bdg., are architects.

Oakland, Cal.—Bids will be received until October 5 by W. D. Pratt, secretary board of education, for construction of addition to University high school. Plans on file with purchasing agent, Board of Education, City Hall.

Salt Lake City, Utah.—Contract for construction of addition to Poplar Grove school has been awarded to J. F. and H. E. Schraven for $23,090.

San Diego, Cal.—Contract for construction of steel and frame laboratory building for Lower California Chemical Co. has been awarded to Wurster Construction Co., Spreckels building.

San Francisco, Cal.—F. Warden, 354 Sussex street, was low bidder at $15,460 for construction of 20 temporary schoolbuildings. Bid was taken under advisement.

Contract for construction of buildings on ranch of James Rolph, Jr., near La Honda has been awarded to McLeran & Peterson, Sharon Bdg., for $13,000.

Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding contract to be awarded for construction of thirty 24-stall concrete roundhouses in Mexico.

San Jose, Cal.—Board of education will receive bids until October 10 for construction of addition to Washington street school. Plans on file with F. G. Aitken, Theatre building.

All bids for construction of addition to Washington school have been rejected because too high and new plans will be prepared.

Santa Cruz, Cal.—Shell Oil Co., 343 Sansome street, San Francisco, will construct distributing station.

Visalia, Cal.—Contract for construction of hotel for J. Sub Johnson has been awarded to Trewhitt-Shields Co., Rowell Bdg., Fresno, for $107,000. Other bidders were: F. J. Amweg, $108,000; Riggins & Palmer, $111,322; Sound Construction & Engineering Co., $119,336; Ward & Goodwin, $119,900; B. T. Owsley, $124,560; H. A. Klyce, $127,700.

Wallace, Ida.—Contract for construction of county hospital has been awarded to A. J. Turner for $58,456.

Washington, D. C.—All bids for construction of stone building at Indian school at Camp Verde have been rejected.

MACHINERY AND SUPPLIES

Berkeley, Cal.—City council has adopted specifications for furnishing motor-trucks for collecting garbage and call for bids will be issued soon.

Los Angeles, Cal.—Harbor commission will receive bids until October 11 for furnishing hoists for warehouse No. 1.

Austin-Western Road Machinery Co. was low bidder for furnishing 18 dump-wagons to city at $150 each for steel axles and $149 each for wooden axles.

Smith-Booth-Usher Co., 228 Central avenue, was low bidder at $550 for furnishing air-compressor, motor, etc., to U. S. Engineer Office.

Santa Rosa, Cal.—Bids will be received until October 3 by H. B. Snyder, city clerk, for furnishing 3000 cu. yd. of crushed basalt rock.

Spokane, Wash.—City clerk will receive bids until October 5 for furnishing a miscellaneous quantity of cast-iron water-pipe specials.

Ventura, Cal.—Bids will be received until October 14 by J. B. McCloskey, county clerk, for furnishing 10,000 bbl. of road oil.

Washington, D. C.—Bureau of Supplies and Accounts, Navy Department, will receive bids until October 10 for delivery at Mare Island, Cal., of condenser-tube sheets, steel nuts, hardware, and pipe fittings. Particulars from Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco.

Bids will be received until October 12 by superintendent of National Parks for furnishing water-wheels, generators, transformers, switchboards, and other hydro-electric machinery at Yosemite National Park. Plans on file with Galloway & Markwart, First National Bank Bdg., San Francisco.

Bureau of Yards and Docks, Navy Department, will receive bids until November 11 for furnishing locomotive jib-crane, capacity 50 tons, for naval station at Pearl Harbor, Hawaii.

Bids will also be received until the same time for furnishing a 250-ton floating revolving crane at Mare Island, California.

MISCELLANEOUS

Oroville, Cal.—Debris dam will be constructed near St. Louis on La Porte road. Estimated cost is $40,000.

San Francisco, Cal.—Bids will be received until October 3 by the lighthouse inspector for docking and repairing Blunt's Reef light-vessel No. 83.

Baker-Joslyn Co., 77 New Montgomery street, was low bidder for furnishing cedar poles for Hetch-Hetchy project at $6.35 each for 35-ft., $7.50 for 40-ft., and $9.80 for 45-ft. poles.

Bureau of Foreign and Domestic Commerce, 306 Custom House, has information regarding firm in Chile which wishes to construct a steam-driven aerial tramway three miles long, capable of handling from 50 to 200 tons per 12 hours.

Santa Ana, Cal.—Contract for furnishing 930 round cedar piles to Newbert protection district has been awarded to J. F. Jones, Seattle, Wash., for $1302.

Tulsa, Okla.—Contract for hauling material for 132-mile pipe-line for subsidiary of Shell Co. has been awarded to H. J. Brandt, Bakersfield, California.

Vallejo, Cal.—Contract for furnishing 5000 ft. of 1-in., 100 ft. of 6-in., and 48 ft. of 14-in. cast-iron water-pipe has been awarded to American Cast Iron Pipe Co., Balboa Bdg., San Francisco, for $2244.45.

BUILDING PERMITS

(Continued from page 404.)

SEPTEMBER 23

Two Two Story Frame Flats—Cost $5000 each. W. J. Keenan, owner. N Grove 90 and 150 W Masonic.

Flat Alterations—Cost $4500. Dr. Kaspar Perchell, owner. 1815 California.

Store and Flat Alterations—Cost $8264. D. M. Moran, owner. SE Haight and Shrader.

One Story Brick Store and Lofts—Cost $11,500. Estate Reuben H. Lloyd, owner. N Sutter 37 E Mason.

SEPTEMBER 25

Two Story Frame Dwelling—Cost $5000. W. S. Oliver, owner. Ashbury Terrace, Lot 2.

Two Story Frame Dwelling—Cost $3000. L. A. Seright, owner. E 34th Ave 200 S Lincoln Way.

Two Story Frame Flats—Cost $5250. J. S. Purcell, owner. E 18th Ave 25 N Anza.

Two Story Frame Flats—Cost $3750. R. Berlacqua, owner. S Glover 137 W Jones.

Two Story Frame Flats—Cost $8000. F. Lundy, owner. NW Chestnut and Polk.

SEPTEMBER 26

Two Story Brick Factory—Cost $33,000. M. A. McLaughlin, owner. W 9th 212 S Harrison.

Four Two Story Frame Dwellings—Cost $3000 each. C. S. Allred, owner. E 24th Ave 106, 131, 156, and 181 N Cabrillo.

Two Story Frame Residence—Cost $3500. St. Francis Home Building Co., owner. S Terrace Drive 140 E Portola Drive.

Three Two Story Frame Dwellings—Cost $3000 each. C. S. Allred, owner. E 24th Ave 206, 231, and 256 N Cabrillo.

SEPTEMBER 27

One Story Frame Stores—Cost $4000. C. H. Westphal, owner. SW Pacific and Polk.

Two Story Frame Flat and Store—Cost $3100. P. D. Expisoto, owner. E Mission 70 N Geneva.

Class 'A' Theatre—Cost $225,000. Market Street Realty Co., owner. SE 4th and Market.

Tenement Alterations—Cost $12,000. A. G. Luchsinger, owner. 945 Golden Gate Ave.

Four Story Class 'C' Apartments—Cost $45,000. O'Brien Bros., owners. S Bush 137 E Mason.

Two Story Frame Store and Flat—Cost $3400. J. Fritzschen, owner. W Mission 25 S Brooks.

One Story Concrete Church (Rear Wing)—Cost $20,000. Rev. P. O'Ryan, owner. W 8th Ave 100 N Geary.

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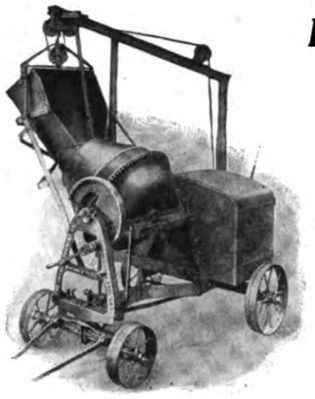

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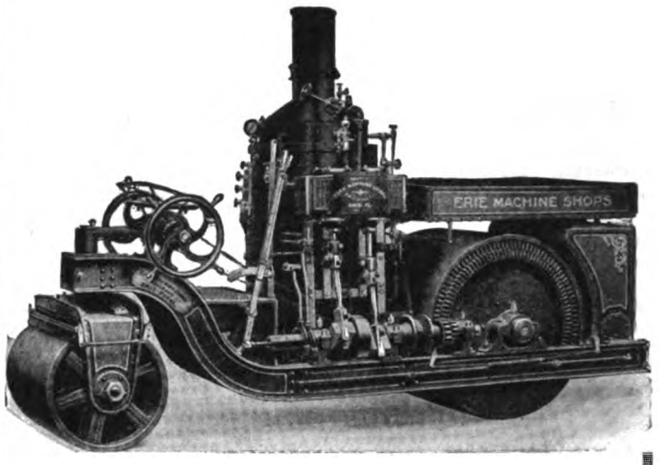

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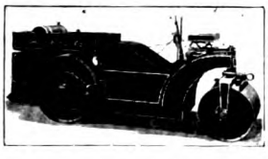

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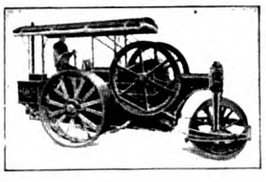

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